oreign
roadcast
nformation
ervice
50
ANNIVERSARY
1941 - 1991

Daily Report
Supplement

East Asia

KOREA
STATUS, PERSPECTIVES OF SEMICONDUCTOR INDUSTRY

FBIS-EAS-91-060-S
Thursday
28 March 1991

East Asia

KOREA

STATUS, PERSPECTIVES OF SEMICONDUCTOR INDUSTRY

FBIS-EAS-91-060-S *28 March 1991*

CONTENTS

[1990 Ministry of Trade & Industry Report on Industrial Technology Requirements — prepared by the Electronics Components Section, Ministry of Trade & Industry and the Korea Semiconductor Equipment Association]

[An • indicates material not disseminated in electronic form.]

1990 Ministry of Trade & Industry Report on Industrial Technology Requirements 1
Background of the Plan to Develop the Semiconductor Equipment Industry
[PANDOCHE CHANGBI, Sep 90] 1
Characteristics of the Semiconductor Equipment Industry 2
World Trend of the Semiconductor Equipment Industry 2
Status of Domestic Semiconductor Equipment Industry 9
Analysis of the Growth Potential of the Domestic Semiconductor Equipment Industry 23
Plan to Promote the Semiconductor Equipment Industry 24
'. Five-Year Plan for Domestic Production of Semiconductor Equipment 25
2. Establishment of Comprehensive Support System to Effectively Promote Domestic Production Plan 44

1990 Ministry of Trade & Industry Report on Industrial Technology Requirements

Background of the Plan to Develop the Semiconductor Equipment Industry

91FE0317 Seoul PANDOCHE CHANGBI [SEMICONDUCTOR EQUIPMENT] in Korean Sep 90 pp 1-104

I. Background of the Plan to Develop the Semiconductor Equipment Industry—Status Summary of Semiconductor and Related Industries

- The domestic semiconductor industry rapidly developed in a short period but related industries are afflicted by extremely unbalanced development

—Semiconductor devices

Memory devices: Korean industry reached third place in the world, and it is expected to reach a level competitive with the United States and Japan when 16/64M DRAM's [dynamic random access memory] are developed.

Logic circuits (ASIC's [application-specific integrated circuit], etc.): Early industrial stage; design technology capability is behind that of even Taiwan.

—Related industries

Raw and secondary materials: Early stages of domestic production (silicon wafers, lead frames, etc.)

Equipment: Early stages of domestic production, most essential equipment are imported.

- External environment of domestic semiconductor equipment industry

External environment

— Because of the deepening dependence on imported equipment, we are worried that both the balanced growth of the semiconductor equipment industry and the growth of the memory device industry may suffer in the future. This scenario emphasizes the need to develop the semiconductor equipment industry.

Domestic environment

— The market for required equipment expanded because of a rapid growth of the domestic memory device industry. This expanded market helps to create an environment favorable to the development of the domestic semiconductor equipment industry.

1. Need Has Arisen to Promote Domestic Production of Semiconductor Equipment on a National Scale

Dependence on imported semiconductor equipment: 96 percent

Ratio of sales versus facility investment (purchase of equipment: 85 percent

- Counter the possibility of restrictions that may be imposed by advanced countries as the international standing of the Korean semiconductor equipment industry improves

— When the competition for the development of 16/64M DRAM's intensifies against advanced countries, they may increasingly use the sale of related equipment as a weapon, such as avoiding (delaying) the sale of such equipment.

United States: Semiconductor manufacturers may exercise their influence and restrict the transfer of key processing equipment for 16M or larger memory devices to Korea because semiconductor manufacturers and equipment manufacturers are jointly developing such processing equipment.

Japan: Japan may use semiconductor equipment as a weapon as Korea becomes a new competitor in the DRAM business.

- Improve international competitiveness of semiconductor products and reduce the trade imbalance with Japan

— The domestic semiconductor industry depends on imports for most of its required equipment.

Importing such equipment puts the Korean industry at a disadvantage in pricing compared to the countries that manufacture their own semiconductor equipment, such as the United States and Japan.

With deepening dependence on Japan, importing semiconductor equipment became a major factor in the trade imbalance with Japan. (In 1989, 95 percent of the equipment was imported from Japan.)

2. Provide Environment for Promoting Domestic Production of Semiconductor Equipment

Domestic market for semiconductor equipment (1989): 840 billion won

Size of facility investment: 14.3 percent of the worldwide facility investment

- Domestic market for semiconductor equipment expands

— Provide motivation for equipment manufacturers to invest by promoting economical market unit for all semiconductor equipment.

— Possibility of manufacturers from advanced countries entering the Korean market

The possibility of technically weaker Korean manufacturers gaining advanced technology [from foreign manufacturers] is increased.

The possibility of technological cooperations with medium and small Japanese venture businesses is increased.

- Strengthen basic capability for domestic production of semiconductor equipment through accumulation of basic technologies by Korean manufacturers

— Accumulate basic equipment development experience at research laboratories

— Develop basis for assembly and production of state-of-the-art equipment with advanced functions and high reliability by accumulating technology through maintenance of imported equipment.

- Expand sympathy for the need to promote domestic production of semiconductor equipment

— Businesses that need semiconductor equipment

Concern for increasing protectionism of technologies in advanced countries.

Securing the basis for domestic production of equipment as businesses reap profit.

— Cooperative mood spreads among businesses related to semiconductor equipment

Between semiconductor businesses and equipment manufacturers; between equipment manufacturers and equipment part manufacturers.

3. The Semiconductor Equipment Industry Is Suitable for Korea as a Promising Industry with Growth Potential

- Possible to utilize skilled and ample technical manpower

— Once essential technologies, such as electronic control, precision machinery control and high vacuum applications, are mastered, the actual manufacturing process consists mostly of operating precision machinery and developing software.

These conditions make this industry particularly suitable for Korea in view of the excellent technical manpower in Korea.

- Medium and small businesses can participate even though the industry is a highly advanced one.

— Because of the industry's dependence on custom-made equipment, the industry is suitable for medium and small businesses except for some equipment.

— It is possible to promote many manufacturers for specialized parts for a given equipment. (Example: Over 1,000 parts must be assembled to manufacture an ion implanter.)

Characteristics of the Semiconductor Equipment Industry

1. Very Short Life-Cycle

- The average life-cycle is 3-5 years due to the yield, which is the basis for the development of semiconductor technology and the competition in the semiconductor market.

2. Knowledge and Technology Concentrated Industry

- Comprehensive technology that combines electronics, materials, machinery, physics, and chemistry.

3. Industry With High Added Values

- Although the processing equipment cost tens of thousands of dollars a piece, the production costs are only 30-50 percent of the total cost. The rest of the production cost depends on the uniformity of processing, reliability of products, improved productivity, and equipment design skill.

4. Great Ripple-Effects on Other Industries

- Secure world's most advanced semiconductor manufacturing technology by developing new processing methods.
- Secure technologies for ultrahigh vacuum, ultrahigh voltage, ultra clean, and ultrahigh precision.
- Promote technologies to process high-precision machinery.
- Guide technology development in industries for high-energy applications.
- Guide the development of new materials.
- Guide technology for developing equipment to analyze material properties.

World Trend of the Semiconductor Equipment Industry

1. World Trend in Semiconductor Facility Investment (World Market Trend)

Status Summary

- The semiconductor industry repeats boom and bust cycles very four years with peaks in the Olympic years, following an empirical business cycle curve known as the silicon cycle.

- Semiconductor facility investments also follow a pattern similar to the silicon cycle with a much larger oscillation every 10 years. (The bust cycles occurred in 1975 and 1985, and another is expected in 1995.)

- The key role in world investments in semiconductor facilities had been played by the United States, but the role shifted toward Japan in the eighties. In this transition period, excessive investments in the two countries made the silicon cycle's downside worse (in 1984- 1985).

- To prevent such oscillations, a cooperative mood is spreading internationally to control facility investments during the boom period to reduce the bust period in the silicon cycle.
- Investments for future-generation devices, such as 4M, 16M, 64M and 256M memory devices, are expected to increase in the nineties.

(a). Trends According to Year and Region

- Annual trend

Table III.1. World Trend in Semiconductor Sales and Facility Investment (in $million)

Year	1986	1987	1988	1989	1990	1991	1992	Average annual rate of increase
Semiconductor sales	29,670	36,498	50,491	55,021	55,436	62,000	81,000	18.2%
Facility investment	5,039	6,136	9,319	10,466	10,377	13,709	23.2%	

Source: Data Quest

Table III.2. World Production of Semiconductor Equipment by Area (in $million)

Year	Total production	U.S.	(%)	Japan	(%)	Europe and others	(%)	Korea
1987	5,043	2,520	50.0	2,098	41.6	414	8.4	11
1988	7,223	3,354	46.4	3,371	46.7	480	6.9	18
1989	9,078	3,996	44.0	4,317	47.6	727	8.4	38

Source: SEMI (March 1990)

Table III.3. Trend by Area (Facility Investments in $million)

Year	1986	1987	1988	1989	1990	1991	1992	Average annual growth rate (%)
World total	5,037	6,136	9,319	10,466	10,377	13,709	17,649	23.3
U.S.	2,066	2,474	3,338	3,672	3,759	4,693	6,118	19.8
	(41.0)	(40.3)	(35.8)	(35.1)	(36.2)	(36.2)	(34.2)	(34.5)
Japan	1,851	2,439	4,587	5,183	4,820	6,700	8,711	29.5
	(36.7)	(39.7)	(49.2)	(49.5)	(46.4)	(48.9)	(49.6)	
Europe	823	843	926	1,066	1,143	1,416	1,724	13.1
	(16.3)	(13.7)	(10.0)	(10.2)	(11.0)	(10.3)	(9.8)	
Others	299	380	468	545	655	900	1,096	24.2
	(6.0)	(6.3)	(5.0)	(5.2)	(6.4)	(6.6)	(6.7)	

Source: VLSI. Percentage in parentheses.

Ratio of Sales to Facility Investment in the United States and Japan

Japan

Investment Trend

- Large-scale investments exceeding 30 percent were made in order to be ready for peak sales.
- These over-30-percent investments were maintained even during the recession in 1985 (investments for the production facilities of future-generation products).
- Investments of the order of 20 percent were made in the seventies and until 1985 when the business cycle was down.
- Aggressive investments were made for 4M DRAM's in 1989 and 1990.

Business Type

- Large conglomerates

— Large-scale investments with mid- and long-term goals.

— Firms were able to invest during recess in production facilities for the future-generation products.

— Advance investments.

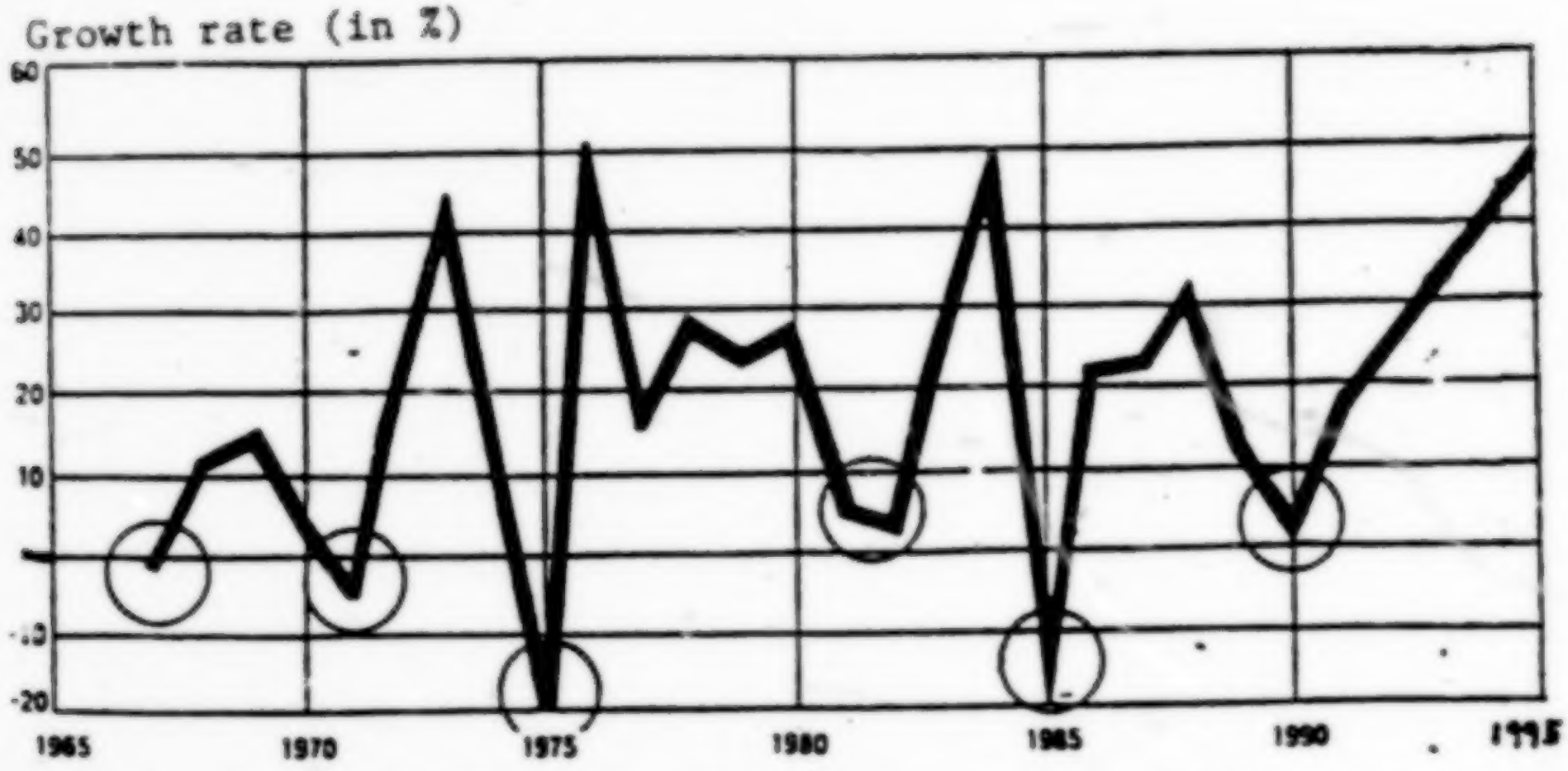


Figure III.1. Silicon Cycle. Semiconductor sales and facility investments increased rapidly in 1984 and 1988, and are expected to increase in 1992 according to the silicon cycle.

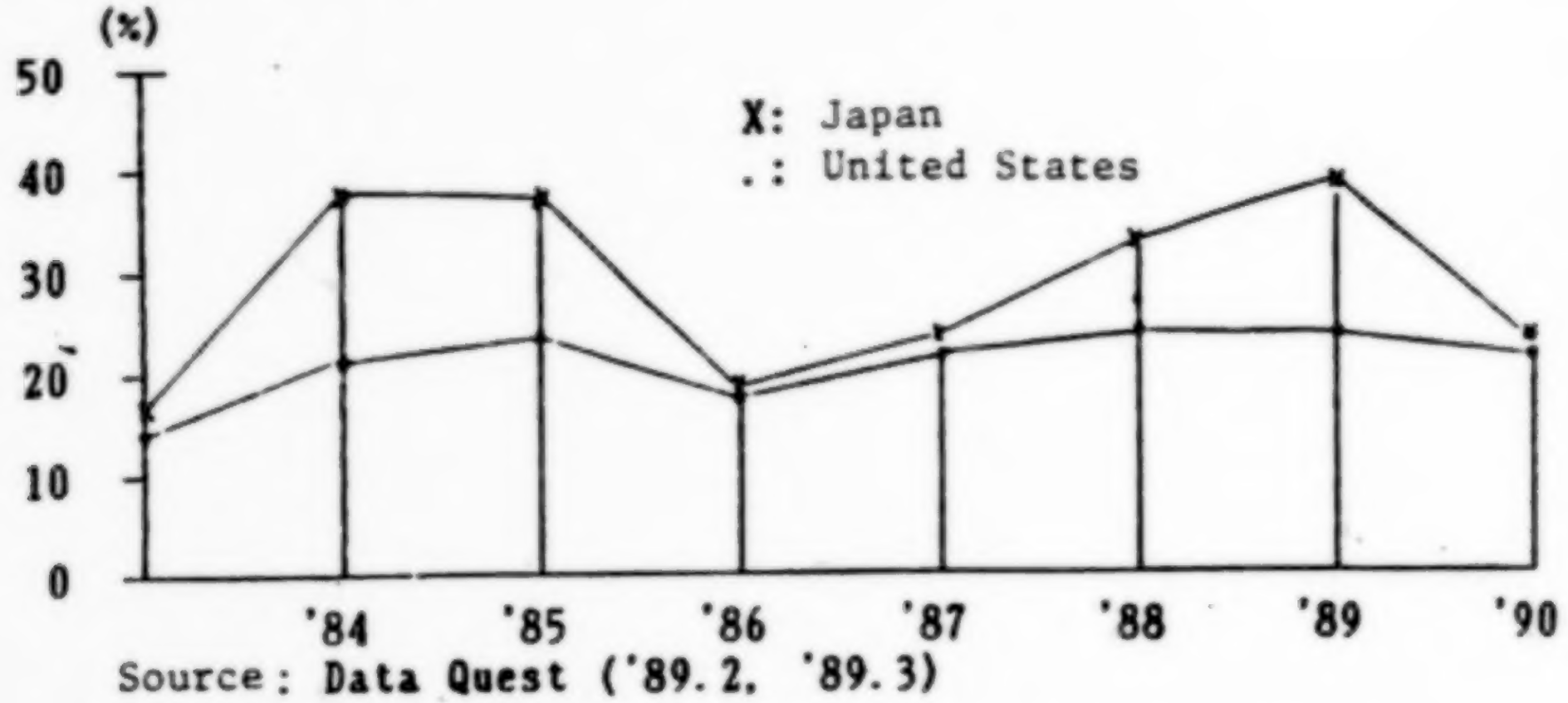


Figure III.2. Trend in the Ratio of Semiconductor Sales to Facility Investments

Government Policies

- Rational and systematic industry development and support by the Ministry of International Trade and Industry [MITI].

— The government provided long-term outlook to help effective investments by businesses.

United States

Investment Trend

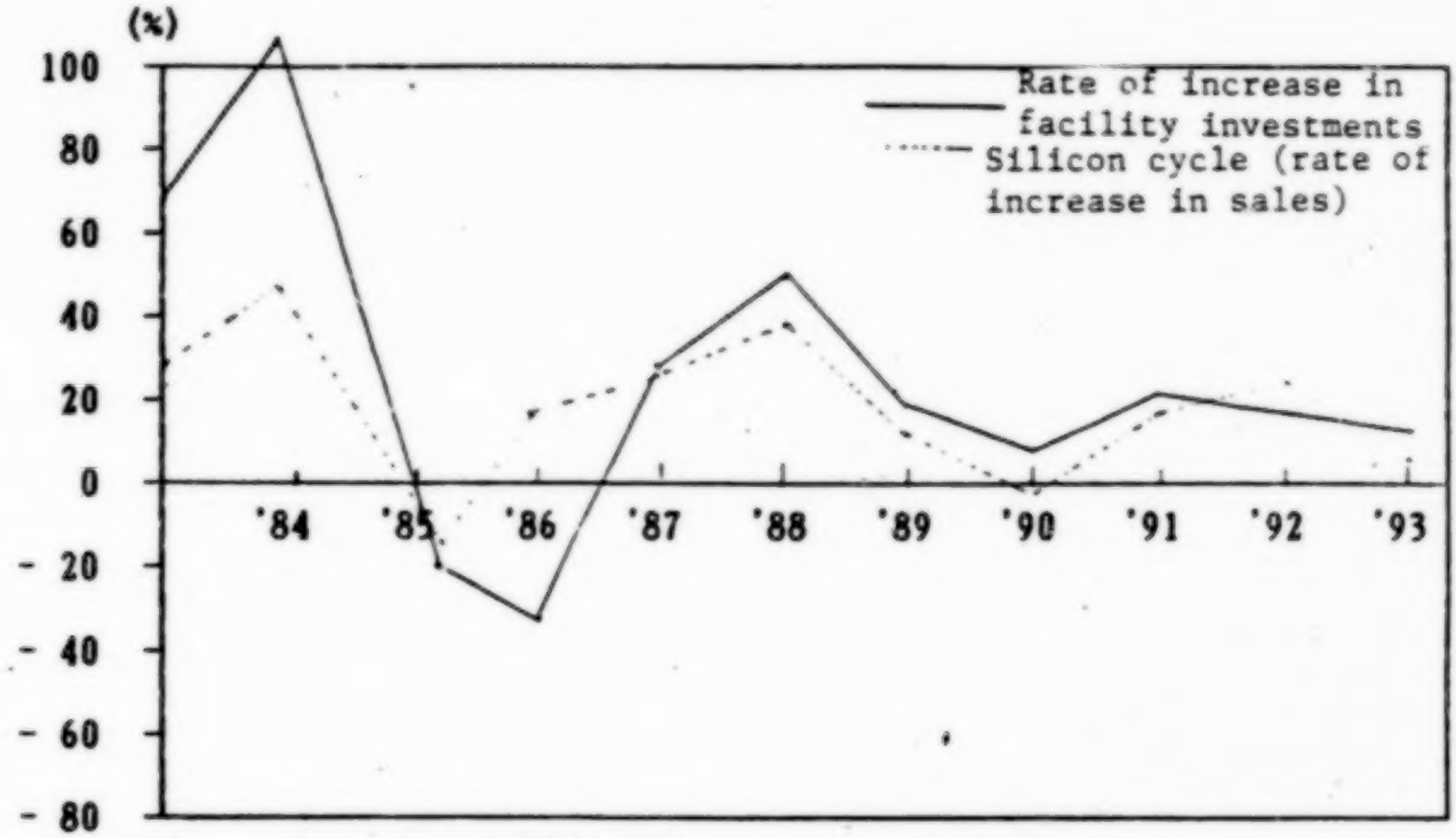
- Businesses invested about 20 percent, 10 percent less than the Japanese investment rate.
- Investments during recess were about 10 percent (twice the average investment rate for American manufacturing industries).
- Joint investments are being made for the facilities and production technologies of the nineties.

Business Type

- Specialized semiconductor manufacturers
- New entrepreneurs

— Difficult to invest more than 20 percent.

— Joint technology development.



Source: **Data Quest ('89. 2)**

Fig.III 3. Year-to-Year Rate of Increase in the Ratio of Semiconductor Sales to Facility Investments

Government Policy

- Termination of free competition among businesses.
- Tougher enforcement of antitrust laws.

— Prohibition of joint development by businesses.

- As a result, many American businesses were weeded out of the semiconductor industry.

— The overall structure of the American semiconductor industry is being adjusted to center around large-scale businesses.

— Effort to improve production technology is under way by activating SEMATECH [semiconductor technology].

— The U.S. government has changed its mood, realizing the necessity for policies to develop [the semiconductor related industry]; the government is relaxing antitrust laws and financially supporting joint developments by businesses.

(b). Variations in the Market Trend for Semiconductor Equipment (Changes in the Facility Investment Strategy by Businesses)

- From the past strategy of "quantitative management" that pursued scale merit:

  To appropriate level of investment — Appropriate level of production — Price increase — Attempt to switch to "qualitative management" typified by an appropriate level of investment

— Avoid excessive investment and supply that ignore the supply and demand in the market, and restrict resulting dumping to expand market share.

— Reduce variations in the rate of increase in facility investments.

*Correlation between the silicon cycle and semiconductor facility investments

— The rate of increase in semiconductor sales peaked in 1984, 1988, and is expected to peak in 1992 as a result of the changes in market conditions in electronic devices, then decreased in the following year (silicon cycle).

— The rate of increase in facility investments also repeats the oscillations in the silicon cycle, with even larger amplitudes.

* Trend in the oscillation amplitude of the year-to-year rate of increase in facility investments

Table III.4.

Before and after the 1984 peak	Before and after the 1988 peak	Before and after the 1992 peak
+100% to -30%	+50% to -1%	+30% to 0%

- Analysis

  Large-scale investments for the purpose of increasing the market share led to worsening trade friction (e.g., the U.S.-Japan Semiconductor Agreement).

  With large-scale integration of semiconductors, the cost of constructing each production line increased rapidly, and as a result, the risk involved in facility investments by businesses also increased.

*Effect of changes in the facility investment strategy by businesses on the semiconductor equipment market

  Reduction of the amplitude in market-size oscillations that exceeded those in the silicon cycle.

  Unlike the past, the semiconductor equipment market is expected to experience continued and stable growth in the future (though the basic pattern in the silicon cycle will be maintained).

2. Worldwide Trend of Semiconductor Equipment Manufacturers

Status Summary

- Although American manufacturers dominated the world market for semiconductor equipment until the mid-eighties, Japanese manufacturers recently have grown rapidly and have exceeded American manufacturers in certain equipment.

— Since the mid-eighties, the American market has been dominated by American manufacturers and the Japanese market by Japanese manufacturers.

— In the nineties, Japanese manufacturers are gradually taking over the American equipment market.

- However, American manufacturers still maintain the world's highest level in basic and fundamental technologies, such as conceptual designs of equipment.

*Background for Rapid Growth of Japanese Manufacturers

— Japanese manufacturers secured technology by starting from assembly production arranged through technology cooperation with American equipment manufacturers.

— After the production base for major components and parts was established in the early eighties, the Japanese manufacturers secured advantageous ground by specializing in semiconductor equipment for the mass production (of memories).

— The fact that Japan had the world's most advanced technologies in related industries, such as high-precision machinery and optics, greatly contributed to the development of the Japanese semiconductor equipment industry.

— Japanese manufacturers have not only won competitions against American manufacturers in the fast growing Asian market in Japan and Korea, which is the world's largest market for equipment, but the Japanese businesses also have built an equipment sales network in the United States.

(a) Current Status of Ten Largest Semiconductor Equipment Manufacturers

Table III.5. (Sales in $million)

Ranking			Manufacturer	Major product	Sales	
1989	1988	1987			508.3	633.9
1	2	6	TEC (Japan)	Various	508.3	633.9
2	1	1	Nikon (Japan)	Stepper	520.7	582.2
3	4	5	AMT (U.S.)	Etcher, CVD	381.7	523.3
4	3	4	Advantest (Japan)	Tester	384.9	398.8
5	6	7	Canon (Japan)	Stepper	289.7	383.6
6	5	3	G.S. (U.S.)	Stepper etc.	375.2	353.7
7	7	9	Varian (U.S.)	Ion implanter	210.9	335.0
8	11	—	Hitachi (Japan)	Stepper etc.	N.A.	210.0
9	9	8	Teradyne (U.S.)	Tester	189.7	199.9
10	13	—	ASM (West Germany)	CVD	N.A.	186.8

Source: VLSI Research (March 1990)

- The world trend is that Japanese manufacturers are rapidly growing and passing ahead of American manufacturers.

— Japanese manufacturers rank first and second.

— Five Japanese manufacturers are included among the ten largest in the world.

- These rankings are the result of the fact that Japanese semiconductor equipment manufacturers are dominating their domestic semiconductor market, which became the largest in the world since the mid-eighties.

- In the nineties, 25 percent of the equipment produced in Japan is expected to be exported, in particular, to the United States.

Table III.6. Ranking in 1979 (sales in $million)

Ranking	Manufacturer	Sales
1	Fairchild Test Systems Group (U.S.)	111
2	Perkin Elmer Corporation (U.S.)	101
3	Applied Materials Inc. (U.S.)	54
4	GCA Corporation (U.S.)	54
5	Teradyne Inc. (U.S.)	53
6	Varian Associates (U.S.)	51
7	Tektronix Inc. (U.S.)	39
8	Eaton Corporation (U.S.)	38
9	Kulicke and Soffa Industries, Inc. (U.S.)	37
10	Balzers AG (Germany)	34

— Of the ten largest manufacturers, nine are American and one European.

— Neither Nikon, which ranked first in 1988 nor TEL, which ranked first in 1988, was included among the 50 largest manufacturers in the world in 1979. Advantest ranked 15th at that time.

— Only four of the top ten manufacturers in 1979 remained in the top ten in 1988.

(b) Analysis of Trend Among Manufacturers by Major Equipment (Based on 1989 Data)

Table III.7.

Equipment	1989 market share (in %)		World market size (in $million)	Remarks
	Manufacturer	Market share		
Stepper	Nikon	46.0	1,030 (in 1988)	Japanese firms dominate most of the world market.
	Cannon	21.0	1,062 (in 1989)	GS recovered to become a major manufacturer in the world by acquiring GCA.
	GS/GCA	12.0		Hitachi became a major manufacturer by producing the i Line Stepper.
	ASM	10.0		
	Others	11.0		
Dry etcher	AMT	31.0	634 (in 1988)	AMT grew rapidly and nibbled into the market share of LAM, which ranked second.
	LAM Research	14.0	784.5 (in 1989)	
	TEL	13.0		TEL rapidly grew from 1988 and is catching up with LAM.
	Others	35.0		In general, American firms are strong.
	Tegal	7.0		
Diffusion furnace	TEC	40.0	284 (in 1988)	The Japanese market is dominated by Japanese firms, such as TEL and Kokusai, and the American market is dominated by American firms, such as Thermco/SVG/ BTU.
	Thermco/SVG	16.0	355.5 (in 1989)	Overall, Japanese firms dominate over American firms.
	Bruce	10.0		TEL has maintained a market share of 40 percent since 1988.
	Kokusai	16.0		
	Others	18.0		
Ion implanter	Low and medium current			
	TEL/Varian	32.6	128.0 (in 1988)	TEL/Varian's market share has increased.
	Varian	38.0	150.1 (in 1989)	Varian is leading the market with a share of 50%.
	Eaton	19.0		
	Nissin	18.0		Nissin of Japan recently began to increase its share.
	Others	9.0		

Table III.7. (Continued)

Equipment	1989 market share (in %)		World market size (in $million)	Remarks
	Manufacturer	Market share		
Ion implanter	High current			
	Varian	27.0	240.0 (in 1988)	Varian and TEC together account for 40% of the market.
	Tel-Varian	18.0	382.5 (in 1989)	
	Eaton	19.0		Eaton is maintaining its second ranking.
	AMT	16.0		American firms are strong.
	Others	20.0		Japanese firms, such as Ulvac and Hitachi, are also manufacturing this type of equipment.
	High Energy			This is specialty equipment with a smaller market.
	Genus	58.0	22.0 (in 1988)	Genus has 58% of the market share.
	Nissin Electric	13.0	43.0 (in 1989)	
	Eaton	18.0		
	Others	11.1		Recently, Shimadzu and AMT joined as new manufacturers.
CVD	AST (PE [plasma enhanced] CVD)	26.0	518 (in 1988)	AMT replaced ASM as the first ranked manufacturer (in PE CVD)
	ASM (PE CVD)	13.0	710.2 (in 1989)	Kokusai and TEL are the leading manufacturers of the LP [low pressure] CVD equipment.
	Kokusai (LP CVD)	7.0		Demands for PE CVD and LP CVD are increasing, thus leading the growth in the CVD market.
	TEL (LP CVD)	6.0		o American firms are strong.
	Genus (W-S)	9.0		
P.R. coater/developer	TEL	26.0	302.0 (in 1988)	Japanese firms are dominating SVG, and also they are nibbling into the American market.
	DNS	22.0	452.5 (in 1989)	
	SVG	14.0		
	Others	38.0		
Sputterer (P CVD)	Varian	23.0	367 (in 1988)	The top three firms has 60% of the market.
	MRC	21.0	415.7 (in 1989)	
	Anelva	14.0		Japanese firms Anelva and Ulvac are growing.
	Ulvac	14.0		
	Others	28.0		
Tester	Logic tester			
	Advantest	29.7	670 (in 1988)	Japanese firms Advantest, Ando and others are leading the market with high-pin, high-speed testers.
	Ando	13.5		
	Schlumberger	13.2		
	LTX	12.5		
	Others	31.1		
	Memory tester			This market grew 76% compared to the previous year from Japanese investments in 1M DRAM facilities.
	Advantest	42.6	298 (in 1988)	Japanese firms are leading the market.
	Ando	12.9		
	Teradyne	11.5		
	Others	33.0		
	Linear tester			
	LTX	32.1	282 (in 1988)	
	Teradyne	29.1		Advantest and Ando together have 55% of the market.
				Teradyne sells in Japan but has only 11 percent of the market.

Table III.7. (Continued)

Equipment	1989 market share (in %)		World market size (in $million)	Remarks
	Manufacturer	Market share		
	Advantest	7.4		Overall, American firms are leading the market.
	Others	31.4		LTX ranks first in market share, and Teradyne ranks second.
Wafer prober	TEL	45.0	268.1 (in 1988)	Fully automated methods are the mainstream.
	General Signal	22.0	337.7 (in 1989)	General Signal ranked first until 1987, but TEL became the leader for the first time in 1988.
	Tokyo Seimitsu	15.0		
	Others	18.0		
Die-bonder	Shinkawa	24.0	82.6 (in 1988)	Shinkawa leads the Japanese market.
	ESEC	21.0	92.5 (in 1989)	ESEC leads the American and European markets.
	K and S	8.0		
	Others	47.0		Others include AMI, Hitachi, etc.
Wire-bonder (Automatic)	Shinkawa	40.0	183.5 (in 1988)	Shinkawa and K&S are competing.
	Kulicke and Soffa	29.0	182.4 (in 1989)	Shinkawa is leading in the Japanese market, and K&S in the American market. ESEC is strong in both America and Europe.
	Kaijo Denki	10.0		
	Others	21.0		

3. Worldwide Technological Trend in Semiconductor Equipment

Status Summary

The technology of manufacturing equipment is developing rapidly in response to high-density integration in semiconductor technology and the demand for improved yield.

(a) Establishing Technology in Response to High-Density Integration in Semiconductor Technology

- Technology development for ultra-fine pattern formation and processing equipment.
- Development of equipment free from particle damage.
- Development of equipment matching consolidated processing.

(b) Measures to Improve Yield

- As a result of larger wafer diameters (IBM, TI), 8-inch wafers are being used at present for 4M DRAM's.
- Automation of equipment to achieve increased yield and production.

Table III.8. Technological Trend in Equipment for the Development of Future Devices

Year	1989	1991	1993	1995	2000
Line width (microns)	0.8	0.6	0.35	0.25	0.15
DRAM capacity	4M	16M	64M	256M	1G
Stepper technology	G-line	G, I-line	DUV	DUV, X-ray	X-ray
Etching equipment	RIE/MRIE	ECR-low temperature	ECR/DECR		
CVD equipment	LPCVD/P CVD	Low-temperature CVD/ECR	CVD/High-vacuum CVD		

Status of Domestic Semiconductor Equipment Industry

1. Status of Domestic Facility Investments (Status of Domestic Industry)

Status Summary

- Since Korea succeeded in independently developing 64K DRAM's in 1983, consolidated production systems through wafer processing have been developed and large-scale investments are being made.
  - — Building production systems for DRAM's (1983-1986).
- Owing to a boom in semiconductors, especially in DRAM's, large-scale investments were made in 1988 and 1989 in constructing production lines for 1M and 4M DRAM's, which are future-generation products.
  - — DRAM's will be developed domestically (1990-1993).

- Production capability for 4M DRAM's is expected to increase starting from 1990, and new facility investments for the construction of 16M DRAM production lines are also expected to increase steadily.
- Facility investments in production systems for ASIC and compound semiconductors are expected to become active in the nineties.

(a) Annual Trend in Facility Investments

Table IV.1. Annual Investment Trend (in 100 million won)

Year	1983	1984	1985	1986	1987	1988	1989	1990 (estimate)	Total
Wafer processing firms	597	2,647	3,265	2,079	2,040	5,021	10,500	5,000	31,149
Assembly production firms	193	620	476	174	158	195	173	146	2,135
Total	790	3,267	3,741	2,253	2,198	5,216	10,673	5,146	33,284

Footnote 1. Wafer processing firms (Samsung, GoldStar, Hyundai, Daewoo, and Korea Electronics)

Footnote 2. Assembly production firms (Anam Industrial, Signetics [Korea], Motorola [Korea], and Fairchild Semiconductor [Korea])

— After 1980, the main contribution to domestic facility investments came from wafer processing firms. (The waver processing industry was introduced into Korea beginning in 1974.)

Table IV.2. Comparison With Worldwide Facility Investments (in $million)

Year	1983	1984	1985	1986	1987	1988	1989	1990	Total
Worldwide total (A)	4,153	8,838	7,231	5,039	6,136	9,319	10,466	10,377	61,579
Domestic wafer processing industry (B)	77	330	377	237	249	717	1,500	700	4,187
B/A (%)	1.9	3.7	5.2	4.7	4.1	7.7	14.3	6.7	6.8

— Domestic investments reached about 5 percent of the world total between 1983 and 1988.

— Domestic investments amounted to 14.3 percent of the world total in 1989.

Investments were concentrated in the production lines for 1M and 4M DRAM's (by three DRAM manufacturers).

In the past, the United States and Japan led the DRAM and other memory chip market, but we expect that Korea, the United States and Japan will compete in the market in the nineties (Korea is expect to take 20-30 percent of the world market).

Table IV.3. Major Facility of the Wafer Processing Industry (in 100 million won).

Year	'83	'84	'85	'86	'87	'88	'89	'90
Total investment	597	2.647	3.265	2.079	2.040	5.021	10.500	5.000
Samsung	('83.9~'84.5) Kihung 1 line (64K DRAM)	('84.9~85.5) Kihung 2 line (256K DRAM)		('87.8 ~ 88.11) Kihung 3 line (1M DRAM)				
			('84.3 ~ '85.3) Puchon C line			('88.10 ~ '89.10) Kihung 4 line (4M DRAM)		
						('88.10 ~ '89.10) Kihung U line (16M DRAM lab.)		
						('88.10 ~ '89.10) Puchon M line (Nicom lab.)		
Hyundai	('84.2 ~'84.11) FAB1 (64K DRAM)	FAB2 ('85.2 ~ '85.11) (256K DRAM, SRAM)		('86.3 ~'86.10) FAB3 (256K DRAM,		('88.12 ~'89.10) FAB4 EEPROM)	supplementary investment	
Goldstar	('83.4 ~ '85.5) Kumi MOS1					('88.10 ~ '89.12) Chongju Plant 1 line (1/4M DRAM)	Chongju 1 line maintenance investment	
	('83.9 ~ '85.1) Anyang Laboratory line							
	('84.10 ~ '86.12) Umyondong Laboratory line							
Daewoo Telecom	('86.3 ~ '86.12) Bipolar line							
						('88.12) CMOS line (CUSTOM IC)		
Korea Electronics	('86.3 ~ '86.12) Bipolar line (Transistor, IC)							
						('88.12) CMOS line (lab) (Transistor, IC)	('88.12) CMOS line	

Table IV.4. Ratio of Investment to Sales (Production) by Domestic Wafer Processing Firms (in 100 million won)

Year	1983	1984	1985	1986	1987	1988	1989	1990	Total
Sales (A)	403	875	1,453	2,654	3,895	9,723	15,866	19,806	54,675
Investments (B)	597	2,647	3,265	2,079	2,040	5,021	10,510	5,000	31,149
B/A (%)	148	303	225	78	52	52	85	25	57

— Facility investments exceeded 100 percent of the sales between 1983 and 1985.

These investments are basic ones common in the early stages of the industry. The rate of investment in the United States is 20 percent and that in Japan is 30 percent.

— The [facility] investments in 1986 were 78 percent of the sales.

When the international semiconductor market experienced recession, investments by the United States and Japan dropped to the 10 percent level.

Investments by Korean firms remained large irrespective of the international market condition because Korea is still in the early stages of the industry.

— The rate of facility investments dropped to 50 percent of sales between 1987 and 1988.

This apparent reduction was caused by the rapid increase in sales (boom in 64K/256K and 1M DRAM sales) as a result of the earlier investments between 1983 and 1986.

The fact that Korean investment is 50 percent while the rates for Japan and the United States remain 30 percent and 20 percent, respectively, indicates that the Korean semiconductor industry has not yet reached a stable stage.

— The investments in 1989 suddenly increased to 85 percent.

The increase resulted from the reentry of GoldStar into the DRAM business and the concentrated investments by Samsung and Hyundai into the construction of production lines for 1M/4M DRAM's.

Increased sales provided the capital for large-scale investments.

Large-scale investments will not be seen in 1990 because investments for 1M/4M chips are being completed.

— Investment levels in 1991 and 1992 are expected to remain around 30 percent as the domestic industry reaches a stable stage.

(b) Future Outlook for Facility Investments by Three Domestic Manufacturers (Between 1990 and 1994)

Table IV.5. Future investments by GoldStar, Hyundai and Samsung (in 100 million won).

Year	1990	1991	1992	1993	1994
Type of investment	Market analysis/outlook for 1M/4M [chips]	Production and increased capacity for 4M DRAM's (switch to 1M [16M?] DRAM's)/			
		Examine facility investment for 16M DRAM's, Serious investment for 16M DRAM production facilities			
	Examine investments for ASIC production facilities				
Invest in ASIC production facilities					
			Investments to replace obsolete facilities in existing production lines (maintenance investments)		
Investing firms					
GoldStar		Chongju II line (4M)		New Fab (16M)	
Hyundai	Maintenance investment in Fab III/PH I	Fab III/PH II (4M)		Fab IV (16M)	
Samsung			Investment in Samsung V line (16M)		
Amount	4,200	8,750	13,125	15,750	10,500
(in $million)	(600)	(1,250)	(1,875)	(2,250)	(1,500)
Investment in actual facility (in $million)	500	1,000	1,500	1,800	1,300

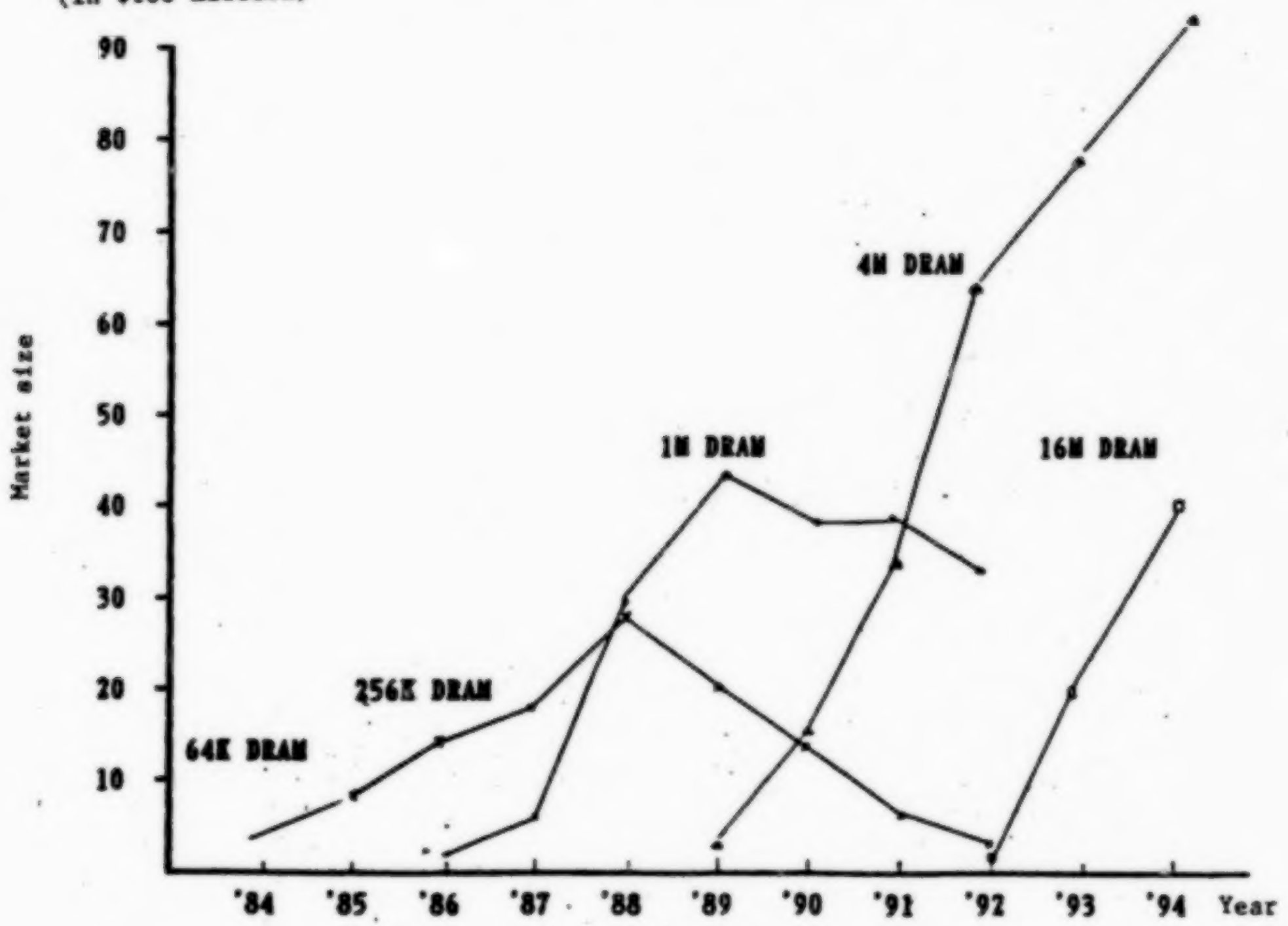


Figure IV.1. Annual Semiconductor Market Size

(c) Outlook for Facility Investments in the Nineties

- Investments in 1990 are expected to be less than those in 1988 and 1989.

— New investments for GoldStar Electron's [Semiconductor] Chongju Plant II line and Samsung's V line are likely to be postponed until the next fiscal year (1991-1992) due to reduced sales resulting from the slow international market for semiconductors.

— The original investment plan for 662.5 billion won is expected to be reduced to 500 billion won.

- Investments in 1991 and 1992 are expected to increase.

— Investments carried over from the previous fiscal year (Chongju II line and Samsung V line) will be executed.

— Replacement investments to increase production capacities for 4M DRAM's will be carried out. Only part of the facilities for 1M DRAM production lines that can be upgraded to 4M DRAM's will be replaced. (Investment size will be small.)

— Annual market size is expected to exceed that of 1988.

- Large-scale investments will continue between 1992 and the second half of 1994.

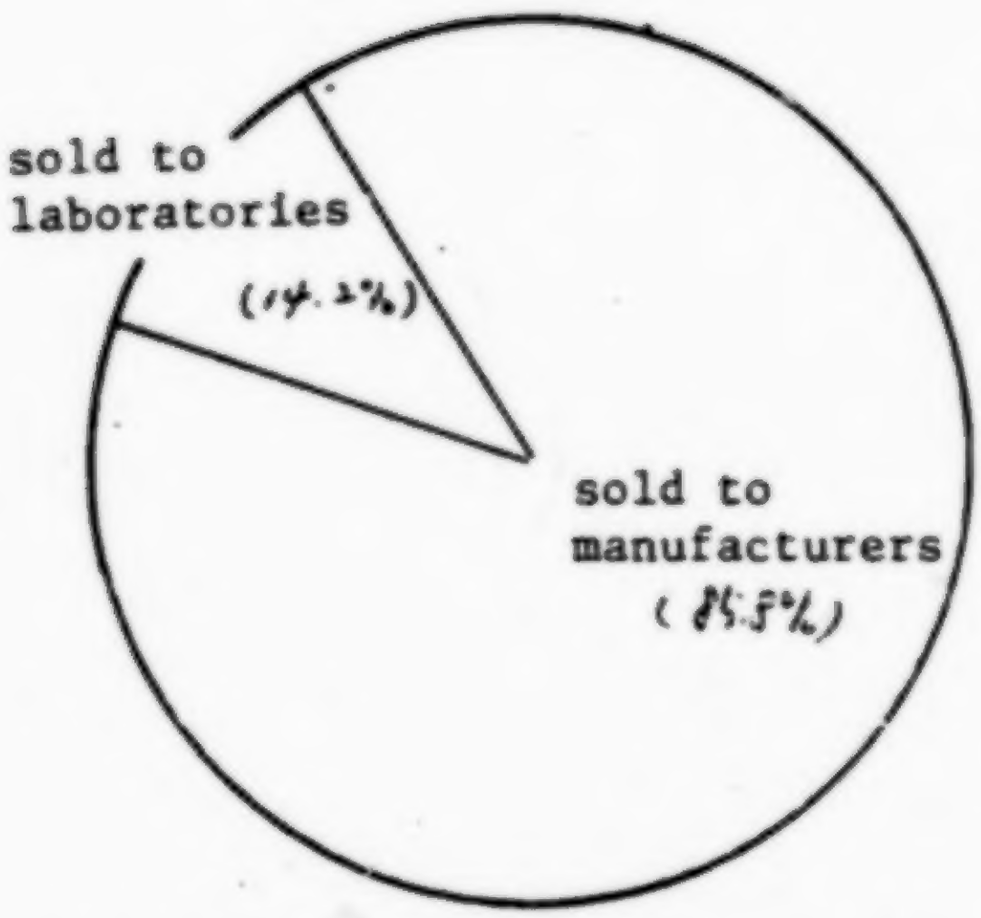
— An investment of about 800 billion won is expected to be required for each production line.

— The domestic market, which will be governed by the facility investments for 16M DRAM's during this period, is expected to far exceed the domestic market between 1989 and 1990, during which time the construction of 1M/4M DRAM production lines was concentrated.

- At present, there are more than 20 domestic semiconductor production lines, and replacement of obsolete facilities in the existing lines will provide an annual domestic market of 100 billion won on average.

- As the domestic ASIC market expands, the construction of production lines dedicated to ASIC's is expected to take place between 1990 and 1994.

— Each production line is expected to cost 100-200 billion won.



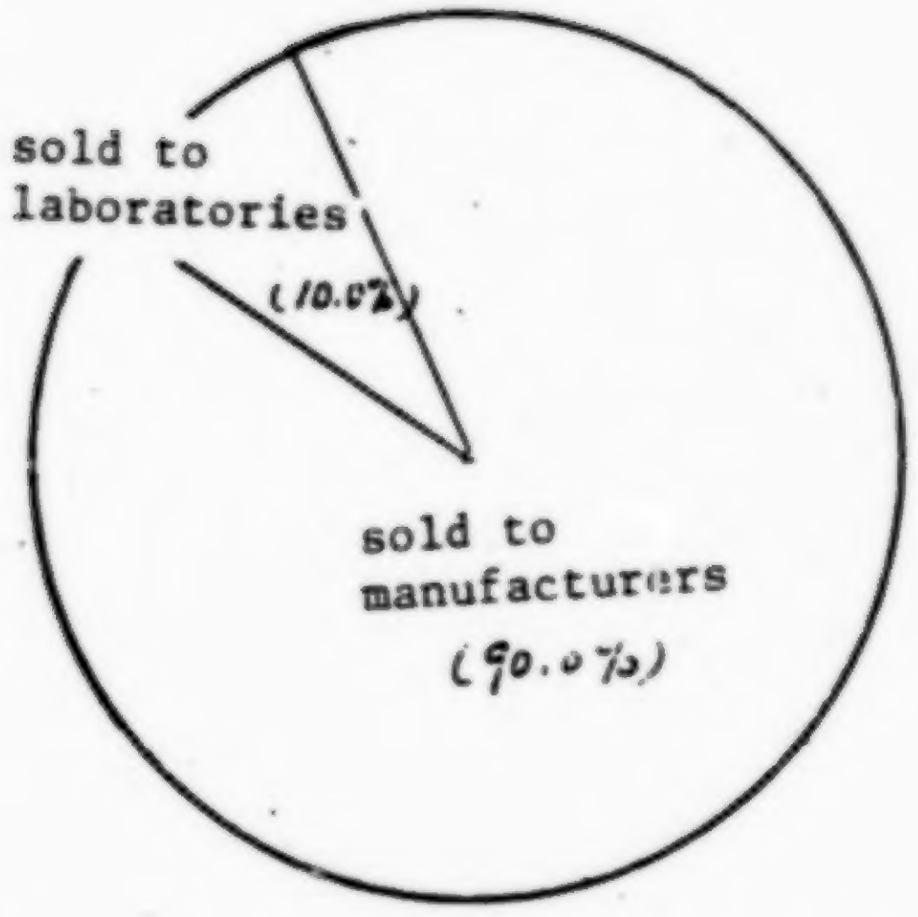


Figure IV.2. Customers of Domestically Manufactured Semiconductor Equipment. Total production in 1988 was 12.7 billion won and 31.8 billion won in 1989.

Table IV.6. Reference Data: Current and Future Status of World Market for DRAMs (in $million).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
256K	868	1,432	1,808	2,673	1,764	1,150	750	456		
1M		134	637	2,763	4,352	3,893	3,910	3,501		
4M					148	1,338	3,517	6,485	7,650	9,000
16M							3	170	1,750	4,000

Source: Data Quest (November 1988).

2. Trend of Domestic Semiconductor Equipment Manufacturers

Status Summary

Business Type

- There are over 80 firms that are engaged in the semiconductor equipment business in Korea, and they are divided into three types.

— The first type: A firm (an agent of a foreign equipment manufacturer) that has transformed into a production equipment manufacturer by importing foreign technology.

— The second type: Specialized manufacturer (with self-developed technology).

— The third type: A firm that uses production equipment or a subsidiary producing equipment for its own use.

Business Size

- Most equipment manufacturers are medium to small businesses with a capital of less than one billion won. These firms are weak in capital, technology and manpower.

Production Status

- Domestic production of semiconductor equipment and related parts in 1988 was worth 12.7 billion won, barely reaching 2.4 percent of the domestic facility investment of 521.6 billion won that year.
- Domestic production of semiconductor equipment and related parts in 1989 reached 31.8 billion won, or 2.5 times the amount produced in 1988. This is 3.8 percent of the total facility investment (841.7 billion won).

— The equipment industry depended on imported major processing and mass production assembly facilities.

— Only peripheral equipment and some assembly equipment were incorporated into the mass production lines of manufacturers who needed such equipment.

— The total number of equipment manufacturers continues to increase, gradually increasing the domestic share of peripheral equipment.

Table IV.9. Status of Manufacturers According to Equipment Produced

Category	Number of firms	1989 status		Remarks
		Firms with actual production	Amount of production (million won)	
Wafer processing equipment	19	11	9,421 (35.4%)	Includes laboratory equipment
Assembly equipment	3	3	3,159 (9.1%)	
Testing equipment	7	7	2,884 (8.3%)	Includes burn-in
Peripheral equipment/ parts	51	25	16,381 (47.2%)	
Total	80	46	31,844 (100%)	

(c) Manufacturer Size and Actual Investments

Table IV.10. [A Typical Firm, Its] Capital and Employees (in million won; persons)

Capital	Sales	Employees				
		Total number (A)	R&D manpower (B)			B/A (in %)
			Total	Bachelor's degree and above	Technicians	
545	4,187	78	18	8	10	23

— A typical firm, on the average, is a small or medium company with a capital of 545 million won and 78 employees.

Such a company is weak in its ability to mobilize investment capital for technology development or production facilities.

For certain facilities, such a company may establish a technological base for assembly production through technology cooperation.

Such a company has an average of 8 R&D staff with a bachelor's degree or above, with weak capability in analysis, improvements and the design of equipment.

Table IV.11. [A Typical Firm, Its] Actual Investments in 1989 (in million won)

Sales (A)	Investments in 1989		B/A	C/A
	Total investments (B)	R&D investments (C)		
4,187	460	214	11%	5%

— Investment to sales ratio is about 11 percent.

— R&D investments amount to 112 [misprint of 214?] million won, about 5 percent of total sales.

Table IV.12. Status of a Typical American and Japanese Equipment Manufacturer (in $million)

Firm	Sales (A)	Investments in 1989		B/A	C/A
		Total investments (B)	R&D investments (C)		
Varian	335.0	102	8	48.7%	3.8%
TEL	633.9	140	15	27.6%	3.0%

(d) Status of Domestic Production of Semiconductor Equipment

- Wafer processing equipment

— Self-developed equipment are simple laboratory equipment with lenient specifications for reliability and productivity.

— An essential piece of equipment, the ion implanter, is being manufactured through technology cooperation with Varian, and [domestically manufactured] implanters have been installed in production lines for memory chips (end of 1989).

— Essential equipment for high-density integration, such as stepper/etchers to be used in lithography, have not been domestically manufactured at all.

— PSK Technology plans to start manufacturing plasma strippers in 1990 through a Korea-Japan joint venture.

- Peripheral Equipment

— This is the type of equipment for which domestic production is actively pursued. Most equipment were domestically developed, and the products are being installed in the production lines of users.

— Future export opportunities are promising for gas cylinder cabinet and wafer cleaning apparatus.

Table IV.16. Status of Domestically Produced Peripheral Equipment (1989)

Equipment	Manufacturer	Customer	Remarks
Wet station	Hanyang Machinery	Samsung, GoldStar, Hyundai	For mass production
	Kyungsung Precision	Samsung, Hyundai	
	Korea Semiconductor Equipment	Hyundai	
	Daeryung Vacuum	Hyundai	
Strip marking M/C	Hanmi Metal Dies	GoldStar	For mass production
	Tongyang Precision	Samsung, Anam, Opto Electronics	
	Far East Numeric	GoldStar	
Laser marking M/C	Taesok Machinery	Korea Electronics	For mass production
Auto frame loader	Hanmi Metal Dies	Samsung	For mass production
Auto trim and forming M/C	Hanmi Metal Dies	Samsung, GoldStar, Hyundai, Daewoo	For mass production
	Ultra Precision Metal Dies	Samsung, GoldStar, Daewoo, Anam	
	Tongyang Precision	Anam	
Wafer auto loader	Daebo Precision	Samsung, Hyundai	For mass production
Gas cylinder cabinet	Hanyang Machinery	Samsung, GoldStar, Hyundai, Daewoo	For mass production
	Kyungsung Precision	Samsung, Hyundai	
	Daeryung Vacuum	Korea Electronics, Opto Electronics	
	Korea Semiconductor Equipment	Korea Electronics, Opto Electronics	
	Dongil Commerce	Samsung	
Gas scrubber	Hanyang Machinery	Samsung, GoldStar, Hyundai, Daewoo	For mass production
	Kyungsung Precision	Samsung, Hyundai	
	Bosung Mechanical Engineering Laboratory	Semiconductor manufacturers	
Probe card	Samho Engineering	Semiconductor manufacturers	For mass production
DC parameter tester	Far East Numeric	Korea Electronics	For mass production
Discrete testing apparatus	Far East Numeric	Korea Electronics	For mass production
Vibration table	Daebo Precision	Samsung, Hyundai	For mass production
	Daeil System	Hyundai	
Vacuum coating equipment	Daeryung Vacuum		For mass production
Tube cleaner	Hanyang Machinery	Samsung, GoldStar, Hyundai, Daewoo	For mass production
	Kyungsung Precision	Samsung, Hyundai	
	Daeryung Vacuum	Korea Electronics, GoldStar	
	Korea Semiconductor Equipment	Korea Electronics, Daewoo, GoldStar	
Outgassing system	Varian Korea	Hyundai Electronics	For mass production
Heat chamber	Dongil Commerce	Samsung, Lucky Advanced Materials	For mass production
Jangle box	Hanyang Machinery	Samsung, Hyundai	For mass production
	Kyungsung Precision	Samsung	
Clean oven	Sinsong Engineering	Samsung	For mass production
Boat loader	Far East Numeric	Korea Electronics	For mass production
Digital weight indicator	Kyungsung Precision	Samsung, Hyundai	For mass production

Table IV.22. Economic Efficiency Analysis of Domestic Market Investments (Continued)

Equipment		Domestic development		Assembly production through technical cooperation with manufacturers with advanced technologies		Plan for desirable domestic production
	PE CVD	o	o	o	o	Assembly production under technical cooperation pursued
	LP CVD	o	x	x	+	Domestic development pursued (1990 goal)
	Sputterer	o	x	x	o	Assembly production under technical cooperation possible
Peripheral equipment	Wet station	o	o	x	+	Production in progress based on domestic development
	Burn-in system	o	o	+	+	Production in progress based on domestic development

Some low-grade specifications may be locally developed.

In this table, "o" stands for yes; "x" for no; and + for maybe.

- Domestic development is being pursued for most assembly equipment.
- Both domestic development and technical cooperation [with foreign firms] are being pursued for testing equipment.
- Assembly production under technical cooperation is being pursued for most wafer processing equipment.
- Domestic development of other equipment based on advanced concepts—such as x-ray beam source system and ion beam stepper—is being pursued with support from the government.

Table IV.23. Economic Market Units Classified by Equipment (in the Case of Assembly Production Through Technical Cooperation With Firms in Advanced Countries) (units: number of equipment)

Unit price of equipment ($1000)	Type of equipment	Market size that forms an economically viable production unit	Domestic market in 1988
30-40	Various parts/peripheral equipment	150-200	100-150
60-100	Wire/die bonder, wafer probe	120-150	120-150
120-200	Wire/die bonder, test handler	72-96	40-60
250-500	Memory tester	48-60	60
600-800	Memory tester, CVD, track etcher, diffusion furnace	24-30	40-50
Over 1,000	Stepper, ion implanter	18-24	40-50
	Sputterer		1

Requirements for Economically Efficient Production

Production of two models of similar equipment (increased demand)

Plant that can also maintain and repair equipment

Domestic production of major components requires a minimum demand of 30 units of a given type of equipment per year.

Analysis of the Growth Potential of the Domestic Semiconductor Equipment Industry

Part 1. Analysis by Growth Element

Table V.1. Analysis by Growth Element

Element	Positive side	Negative side	Growth direction
Supply and demand	o Promote domestic production of equipment	o Little cooperation between users semiconductor manufacturers and suppliers equipment manufacturers	o Establish close cooperation between users and suppliers
	—Form economically efficient market for each type of equipment	—Horizontal cooperative system absent	—Planning stage for domestic production
	—Promote domestic production of equipment needed by users; Let the users appreciate the need for domestic production	—Means for exchange of ideas absent	Cooperation (through technical cooperation, joint development, etc.) to develop high-performance, advanced-function equipment
	—Secure financial reserve for domestic production as users become profitable	—Lack of mutual understanding of the feasibility of promoting domestic production	Guarantee demand for equipment
	—Manufacturers' active willingness to invest	Manufacturers' doubt on their domestic production capability	—Development stages
		—Uncertainty in purchasing of domestically produced equipment by users	Mutual exchange of engineers/technology
			Loaners to allow analysis of worn-out or outdated equipment
Technological level	o Technology accumulation through repair/maintenance of imported equipment	o Weak in systems analysis/improvement/design capability	o Train skilled manpower
	—Availability of well-trained manpower	—Lack of specialized R&D manpower	o Establish technology through aggressive technical cooperation with technologically advanced firms
	—Establish basis for assembly production of equipment	—Weak foundation for peripheral equipment industry, such as parts	o Promote domestic production of parts in parallel
	o Accumulate experience with system development through the development of basic equipment at a laboratory level		
	—Strengthen foundation for domestic production of equipment		
Marketing	o Accurate understanding of user need by acting as agents for foreign equipment manufacturers	o Difficulty in finding customers for domestically developed equipment due to the lack of a guarantee for performance and reliability of such equipment	o Aggressive cooperation between users and suppliers from the planning stages of domestic equipment production
	—Rational predictions of user requirements possible		—Users should support domestic equipment manufacturers' contact with foreign firms with advanced technology
	—Accurately understand domestic marketing structure		—Equipment manufacturers should try to produce equipment with little domestic technical expertise, such as essential processing equipment, through technical cooperation [with foreign firms]
	—Maintain close contact with users on each type of equipment produced domestically		—Promote joint development with users of the equipment targeted for domestic development
Capital	o Capital needed in early stages of production is not large	o Inability to raise all of the needed capital by individual suppliers	o Promote effective/selective government support

Table V.1. Analysis by Growth Element (Continued)

Element	Positive side	Negative side	Growth direction
		—Cost of technology development (importing technology)	
		—Cost of facility investment and plant site purchase	
		—Cost of manpower training	
International cooperation (joint venture, technical cooperation)	o Increased possibility of advanced foreign firms investing in Korea as the absolute size of the domestic market grows and the market stabilizes	o Paucity of firms with enough capital and technical ability to actively respond to international cooperation initiatives among domestic manufacturers of specialized equipment	o Select suitable foreign firms for technical cooperation through accurate analysis of international market share and their technical competence
	—In America and Japan, where the market is vast and stable, it is impossible to expand our current market share in a short period	o If large users try to manufacture their own equipment, then the possibility of an equipment manufacturer's market being limited to only the market under its own control increases because equipment is manufactured only after orders are received. Under these circumstances, foreign firms are expected to avoid [investing in Korea or technical cooperation]	—Establish mutual, cooperative system between users and suppliers to help the latter obtain technical cooperation with foreign firms
	—The Korean market is in its early stage of dynamic expansion. American and Japanese firms are expected to compete in investing in Korea		
	o Advantages of domestic production factors		
	—Relatively cheap labor cost		
	—Well-trained and diligent technical manpower		

2. Overall Assessment

- The Korean market has sufficient potential
- When the development of the equipment industry is carried out under comprehensive/rational planning, the industry has the potential to grow and develop into an export industry beyond the simple goal of domestic production

Plan to Promote the Semiconductor Equipment Industry

Goals - Through 1994 -

- Domestic production of all essential equipment
- Fifty percent of equipment domestically produced
- Fifty percent of parts for each type of equipment domestically produced

- Post 1994 -

- Establish foundation for entirely domestic production of next- generation equipment
- Develop the industry into an export industry

Implementation Guideline

- Accurate analysis and presentation of the phase [current status] of the domestic semiconductor equipment industry

— Induce aggressive investment in equipment that already forms an economically viable marketing unit.

- Express government's firm intention to promote semiconductor equipment industry and urge businesses to affirm their desire for domestic production
- Reduce losses resulting from trial-and-error methods by providing a comprehensive picture. Aim for effective promotion of domestic production

— Prevent waste of limited manpower and material resources resulting from redundant investments, and guide [the private sector] to achieve effective investments from a national viewpoint.

— Promote effective domestic production by establishing a cooperative system between equipment users and manufacturers.

— Encourage conglomeration of equipment manufacturers and parts manufacturers.

— Provide efficient/selective support using limited government financial resources.

Outlook

- Production is expected to increase rapidly after 1990 as domestic industry is aggressively promoted.
- Firms with their own production plants are expected to increase from 17 (in 1988) to 40 in 1992.

(a) Actual Production

- Production of semiconductor equipment in 1988 was worth 12.7 billion won, representing a mere 2.4 percent of the total domestic market in facility investment.
- Production of semiconductor equipment in 1989 was worth 31.8 billion won, still representing only 3.8 percent of the total domestic market, but it is an increase of 148 percent from the production in 1988.

Table IV.7. Domestic Share of the Equipment Market (in 100 million won).

Year	Domestic equipment productior	Domestic equipment market	Market share of domestically manufactured equipment
1988	127	5,216	2.4%
1989	318	8,417	3.8%

- Production according to equipment type (1989)

— The majority of the domestic production is peripheral equipment, amounting to 47.2 percent of total domestic production.

— Domestic production of mass production equipment for wafer processing facilities is minute: only ion implanters for mass production are being manufactured.

— Some assembly and testing equipment at the individual device level is being manufactured domestically.

• Japanese equipment production reached $3.8 billion in 1988, mostly in wafer processing facilities, which have high added value. The Japanese production matches the world standard in equipment production classified according to manufacturing processes.

- Analysis of customers of domestically manufactured equipment

— Of the domestically manufactured production equipment, 85.8 percent in 1988 and 90.7 percent in 1989 were sold to semiconductor manufacturers and used in actual production lines.

(b) Current Status of Manufacturers

Table IV.8. Status of Semiconductor Equipment and Related Manufacturers Classified According to Business Type

Category	Number of firms	1989 status		Remarks
		Firm with actual production	Amount of production (million won)	
Domestic trading agent for foreign equipment	29 (36%)	6 (22%)	7,196 (23%)	Technology accumulation through A/S [assembly system?]
				Domestic production through technical cooperation with existing trading partners
Specialized manufacturer with self-developed technology	25 (31%)	25 (78%)	23,548 (74%)	Majority of current domestic production
Equipment manufacturer providing own needs	4 (5%)	2 (11%)	1,100 (3%)	Firms specializing in semiconductor assembly
				Subsidiaries of semiconductor manufacturers
Korean branch of foreign firms	7 (8%)	—	—	No production activity
				Firms selling imported equipment
Others	16 (20%)	—	—	Materials manufacturers, facility installers, trading companies
Total	81 (100%)	33 (100%)	31,844 (100%)	

Table IV.16. Status of Domestically Produced Peripheral Equipment (1989) (Continued)

Equipment	Manufacturer	Customer	Remarks
Auto washing M/C	Daeryung Vacuum	Korea Electronics, GoldStar	For mass production
	Korea Semiconductor Equipment	Korea Electronics, Daewoo	
Vacuum tweezer	Daeryung Vacuum	Korea Electronics, GoldStar	For mass production
	Korea Semiconductor Equipment	Korea Electronics, Daewoo, GoldStar	
Bellow pump	Dongil Commerce	Samsung	For mass production
Rotary vacuum pump	Wonchang Vacuum	GoldStar, KAIST	For mass production
Diffusion pump	Daeryung Vacuum	SNU, Korea Electronics, ETRI	For mass production
Auto dispenser	Hanyang Semiconductor Precision	Semiconductor manufacturers	For mass production
Tapping M/C	Taesok Machinery	Korea Electronics	For mass production
Bonding tool	Myongil Precision	Semiconductor manufacturers	For mass production
Pellicle	Fine Semiconductor Technology	Samsung, GoldStar, Hyundai	For mass production
Lead frame magazine	Mirae Industries	Samsung, GoldStar, Hyundai	For mass production
Preformer	Tongyang Precision	Samsung, Anam, Lucky	For mass production

Table IV.17. Status of Equipment Production According to Processes (in million won)

Process	1988	1989		1990		1991	
		Production	Growth rate (%)	Production (estimate)	Growth rate (%)	Production (estimate)	Growth rate (%)
Fabrication equipment	3,444	6,296	182	8,479	35	11,305	133
Test equipment	720	3,159	438	2,844	-10	3,790	133
Assembly equipment	473	2,883	609	2,595	-10	3,459	133
Utility and others	8,043	16,381	203	14,743	-10	19,657	133
Total	12,680	31,844	251	28,661	-10	38,211	133

(e) Status of Top 12 Domestic Equipment Manufacturers in Sales (1988-1989)

Table IV.18. Status of Top 12 Domestic Equipment Manufacturers (1988-1989)

Firm	Product		Sales (million won)	
	Process	Equipment	1989	1988
Varian Korea	Fabrication	Ion implanter, sputterer, outgassing system	6,296	2,100
Hanyang Machinery	Fabrication	Gas bombe-box, gas scrubber, tube cleaner	5,300	3,072
Hanmi Metal Dies	Assembly	Auto frame loader, auto trim and forming M/C, auto shuttle T/F M/C	3,060	2,259
Kyungsung Precision	Fabrication	Gas bombe-box, gas scrubber, wet station	2,200	1,270
Daeryung Vacuum	Fabrication	Vacuum vapor depositor (for laboratory use), diffusion pump, PE CVD (for laboratory use)	1,800	831
IC TEC	Fabrication	Burn-in system, diffusion furnace (for laboratory use), LP CVD (for laboratory use)	1,400	1,003
Far East Numeric	Ate [automated test equipment], assembly	IC tester, TR tester, boat loader	1,400	610
Mirae Industries	Ate, assembly	Handler, lead frame magazine	1,200	90
Taesok Machinery	Ate	Die bonder, wire bonder	1,200	New
Tongyang Precision	Fabrication	Marking M/C, preformer, hydraulic press, pneumatic press	700	489
Daebo Precision	Peripheral equipment	Auto loader, dashpot	650	400
Dongil Commerce	Fabrication	Heater chamber, bombe-box, RTP	600	740
Total			25,806	12,864

3. Domestic Market Status and Economical Efficiency Analysis of Investment According to Equipment

(a) Status and Outlook of Domestic Market According to Equipment

Table IV.19. Status of Domestic Market According to Equipment

Equipment	Number of units (1988)	Unit price ($10,000)	Domestic market ($million)	Manufacturer (imported from)
Stepper	54	150	81	Nikon, Canon
Track	40	90	36	TEL, SVG
Etcher	57	60	34	AMT, LAM, TEL
Diffusion furnace	100			
- H type	60	60	36	TEL, BTU (decreasing)
- V type	40	50	20	Kokusai (increasing), TEL
CVD	15	60	9	AMT, TEL
Ion implanter	40	120	48	Varian, Eaton
Sputterer	15	180	27	Varian, MRC
Memory tester	56	50	28	Advantest, Ando, Minato
Wafer prober	170	10	17	EG, TEL
Test handler	230	12	28	Symtek, Ando
Die bonder	60	10	6	EG, TEL
Wire bonder	40	7	3	Shinkawa, AMT
PR stripper	22	30	7	PSC
RTP	4	30	1	AGA, Peak

Table IV.20. Number of Equipment Required in a Memory Mass-Production Plant According to Memory Size (3 million chips/month production assumed)

Equipment	256K DRAM	1M DRAM	4M DRAM
Stepper	20	30	40
Etcher	10	20	40
Diffusion furnace	15	20	20
CVD	7	10	20
Ion implanter	10	20	30
Sputtering	5	20	30
Memory tester	8	15	30
Dicing	3	3	3
Mounter	8	8	8
Bonder	15	15	20
Total capital investment	$200million	$250-300million	$400-500million

Source: Nomura Research Laboratory (Japan)

— Capital investment needed for each manufacturing plant is increasing because semiconductors are being integrated at higher densities. In the case of a plant for 4M DRAM's, the cost is more than double that of a plant for 256K DRAM's.

— The cost of building a plant with a capacity to manufacture 3 million 16M DRAM chips per month is expected to be over 800 billion won.

Table IV.21. Outlook for Equipment Market After 1990 (Not Facility Investment) (in 100 million won)

Year	1988	1989	1990	1991	1992	1993	1994
Equipment market	5,021	8,417	5,400	6,625	9,500	15,000	7,500
Comparison to 1988 (%)	100	168	108	132	189	298	149

— Domestic market in 1990 is expected to decrease. Facility investment is expected to decrease as a result of reduced sales following slow world market for semiconductors.

Large investments by domestic semiconductor manufacturers were completed in 1989, and very few new investments were made in 1990.

— Domestic market is expected to expand after 1991. World market for semiconductor entered a boom phase.

Domestic market is expected to peak in 1993-1994.

— Domestic market in 1991-1993 is expected to exceed, on average, the 1988 market for each type of equipment . Equipment requirements will increase at a rate of 20-30 percent; the total value is expected to reach a peak of about 1.5 trillion won in 1993.

(b) Analysis of Economic Efficiency of Investments in Domestic Market

Table IV.22. Economic Efficiency Analysis of Domestic Market Investments

Equipment		Domestic development		Assembly production through technical cooperation with manufacturers with advanced technologies		Plan for desirable domestic production
		Formation of economical market unit	Possibility of independent development	Formation of economical market unit	Possibility of technical cooperation	
Processing equipment	Stepper	o	x	o	x	Assembly production through technical cooperation
	Ion implanter	o	x	o	o	Assembly production through technical cooperation already in progress
	Dry etcher	o	*o	o	+	Assembly production through technical cooperation planned (along with some domestically developed specifications)
	PR coater/developer	o	x	o	o	Assembly production through technical cooperation
	RTP	+	+	x	o	Production through technology import planned
	MBE (Laboratory use)	+	o	x	x	Domestic development pursued
Assembly equipment	Die bonder (auto)	o	o	x	o	Domestic development pursued (some specifications and technology will be imported)
	Wire bonder (auto)	o	o	x	+	Domestic development pursued (some specifications and technology will be imported)
	Molding M/C (auto)	o	o	x	+	Domestic development pursued/candidate for export
	Marking M/C (new)	o	o	x	+	Domestic development pursued/candidate for export
Testing equipment	Test handler (for mass production)	o	+	x	o	Assembly production in progress under technical cooperation
	Memory tester (ATE)	o	+	o	o	Assembly production in progress under technical cooperation
	Logic tester (ATE)	o	+	+	+	Domestic development (long-term plan)
Wafer processing equipment	Diffusion furnace	*o	o	o	o	Assembly production pursued under technical cooperation (along with domestically developed specifications)

Table IV.13. Details [of Domestically Produced Semiconductor Equipment] (1989)

Equipment	Manufacturer	Customer	Remarks
Ion implanter	Varian Korea	Samsung, GoldStar	For mass production
Sputter	Varian Korea	GoldStar Electric	For laboratory and industrial applications
	Daeryung Vacuum	Pohang Institute of Science & Technology [POSTECH]	
	Shinyoung High-Tech	KAIST [Korea Advanced Institute of Science & Technology]	
	Taelim Engineering	ETRI [Electronics & Telecommunications Research Institute]	
	Chingong Kisul [Vacuum Technology]	POSTECH	
Furnace	Taesan Engineering	ETRI	For laboratory use
	Korea Semiconductor Equipment	Seoul National University [SNU]	
CVD	Shinyoung High-Tech	KAIST	
—PE CVD	Daeryung Vacuum	Kyongbuk University	
—LP CVD	Korea Semiconductor Equipment	SNU, ETRI	
—MO CVD	Taesan Engineering	KAIST	
Etcher	Vacuum Technology	KAIST	
	Fine Semiconductor Technology	ETRI	
RTP	Shinyoung High-Tech	Hanyang University	
PR Stripper	Seoul Electron	ETRI	
Vapor depositor	Daeryung Vacuum	Hyundai, SNU	For laboratory and industrial use
	Shinyoung High-Tech	KAIST, ETRI	

- Test Equipment

— Tester handlers are manufactured by Symtek Korea, a joint venture between a Korean firm and an American firm.

— Domestic production began on testing equipment for technically simpler individual devices, such as transistors.

— Test equipment for memory and logic chips, which must be highly functional and reliable, are all imported.

— Development for mass production of burn-in systems has been completed.

Table IV.14. Status of Domestically Produced Test Equipment (1989)

Equipment	Manufacturer	Customer	Remarks
Burn-in system	Dongil Commerce	Samsung, GoldStar	For mass production
	Korea Semiconductor Equipment	Laboratories	For laboratory use
IC/DC tester	Far East Numeric	Korea Electronics	For mass production
Test handler			
—Memory	Symtek Korea	Samsung	
—Non-memory	Mirae Industries	Samsung, Daewoo, GoldStar	
Probe	Taesok Machinery	Korea Electronics	For laboratory use

- Assembly Equipment

— High-pin assembly equipment, which must be highly functional and reliable, is entirely dependent on import.

— A small basic bonder (not for mass production) which is technically simple is domestically manufactured. A bonder for mass production is being developed.

— Price and quality of molding M/C are internationally competitive. This equipment is a candidate for export.

Table IV.15. Status of Domestically Produced Assembly Equipment (1989)

Equipment	Manufacturer	Customer	Remarks
Die bonder	Taesok Machinery	Korea Electronics	For mass production
Wire bonder	Taesok Machinery	Korea Electronics	For mass production
Molding M/C	Hanmi Metal Die	Samsung, GoldStar, Hyundai	For mass production

Major Components of a Plan to Promote Semiconductor Equipment Industry

1. Carry out a five-year plan (1990-1994) for domestic production of semiconductor equipment.

2. Establish a comprehensive support system to efficiently promote domestic production plan.

a. Provide effective support through the government's technology development fund.

b. Train specialized manpower.

c. Study methods to utilize experts in government-financed laboratories/academic laboratories.

d. Help semiconductor equipment manufacturers to acquire plant sites.

e. Stimulate activities of the Semiconductor Equipment Association.

f. Promote the development of test products using the industrial development fund.

g. Promote joint investments in manufacturing firms that specialize in essential-equipment production.

h. Establish a comprehensive research laboratory for semiconductor equipment.

i. Establish a Committee to Promote Domestic Production of Semiconductor Equipment.

j. Send delegates to advanced countries to promote technical cooperation.

k. Strengthen public relations activities in Korea and abroad.

l. Study means to expand the use of domestically produced equipment (provide support to users).

1. Five-Year Plan for Domestic Production of Semiconductor Equipment

Equipment to Be Emphasized for Domestic Production

- Equipment that forms economically viable marketing unit
- Manufacturing equipment for which that user firms recognize the need for domestic production
- Equipment based on future concepts that should be studied and developed as part of a government policy

Strategy for Domestic Production

1. Equipment for which domestic technical foundation is very weak.

- Promote assembly production through technical cooperation with firms with advanced technology
- Promote research on systems analysis and improved performance
- Promote domestic production of essential parts for five years

2. Post-processing equipment that is technologically accessible.

- Promote independent, domestic development
- Attempt joint development by industry, academia and research laboratories

3. Future-generation equipment that is being studied in advanced countries but not yet commercialized.

- Promote R&D as government-guided topics
- Promote research in government-financed laboratories by using domestic experts
- Encourage participation of firms with well-established financial and technical resources

(a) Summary of Domestic Production Plan

Table VI.1. Current Status and Future Plan to Promote Assembly Production Through Technical Cooperation

Equipment	1990	1991	1992	1993	1994	1995
Promote domestic production of essential, special parts						
Stepper						
Dry etcher						
Diffusion furnace						
PE CVD						
Ion implanter	Being promoted	Being promoted				
Sputterer		Being promoted				
Memory tester						
Test handler	Being promoted	Being promoted	Being promoted			
Wafer prober	Being promoted	Being promoted	Being promoted			
PR Stripper	Being promoted	Being promoted	Being promoted			

Table VI.2. Budget for the Above Plan (in 100 million won)

Year	1990	1991	1992	1993	1994	1995
Required R&D budget	3	37	45	40	38	30
Government support	2	26	32	28	27	20

- Goal for R&D financial support: Domestic production of essential, specialized equipment
- Method for R&D financial support: Announce the type of businesses targeted for domestic production in machinery, parts and materials
- Financial source: Industrial development fund, fund to establish medium and small business structures

Table VI.3. Current Status and Future Plan for Equipment to be Independently and Domestically Developed and Produced

Equipment	1990	1991	1992	1993	1994	1995
Diffusion furnace (Korea Semiconductor Equipment)	Being promoted				[To be developed as] future-generation [equipment]	
LP CVD (Dongil Commerce)	Being promoted				Future generation	
Dry etcher (Chein Technic)	Being promoted					
Logic tester (Far East Numeric)	Being promoted					
MBE (industry, academia and research laboratories)	Being promoted				Future generation	
Burn-in system (Dongil Commerce)	Being promoted					
Die bonder (auto) (Taesok Machinery)	N	Improve performance				
Wire bonder (auto) (Taesok Machinery)	N	Improve performance				
Molding M/C (auto) (Hanmi Metal Dies)	N					
Marking M/C	N	Improve performance				
Wet station (auto) (Hanyang Machinery)	Being promoted					
Wafer prober		Planned for promotion				

Table VI.4. Budget for the Above Plan (in 100 million won)

Year	1990	1991	1992	1993	1994	1995
Required R&D budget	20	24	20	20	20	15
Government support	20	17	12	12	12	10

- Goal for R&D financial support: System development (including domestic production of essential, specialized parts)
- Method for R&D financial support: Announce basic industrial technology development projects
- Financial source: Basic industrial technology development fund

Table VI.5. R&D to be Promoted Under Government Guidance

Equipment	1990	1991	1992	1993	1994	1995
X-ray beam source (SOR) system			xxx	xxx	xxx	
Ion-beam lithography system			xxx	xxx	xxx	xxx

Table VI.6. Budget for the Above Plan (in 100 million won)

Year	1990	1991	1992	1993	1994	1995
Required R&D budget	—	—	15	23	20	7
Government support	—	Full support by the government				

1) Stepper

(a) Annual Plan for Domestic Production

Table VI.12. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Stepper		Begin assembly production of 1/4M-class chips		Assembly production of 16M-class chips		
			System performance analysis			
			Promote domestic production of parts			
Expected number of steppers needed		30	40	60	30	10
Goal for domestically produced steppers	—	?	?	?	?	?
R&D cost of specialized parts (100 million won)	—	—	12	12	10	—
Estimated unit price	$1.6 million					
Main applications	1/4M-class chips		4/16M-class chips		16M-class chips	
Major Parts to be Manufactured Domestically						
Specialized parts			General-purpose parts			
Beam source/high intensity illuminator			Power supply			
Optical system			Wafer handling system			
Automatic reticle system			Vacuum system			
Automatic alignment assembly						
Pattern generator						
Automatic focusing system						
Image repeater						

(b) Possibility for Technical Cooperation

Table VI.13. Current World Market Share (in $million)

Year	Market size	Market share (%)			
		Nikon	Canon	General Sig.	Others
1988	1,030	48.9	17.9	7.2	26.0
1989	1,209	46.0	21.0	12.0	21.0
Among semiconductor equipment, this is equipment in which Japan dominates.					

Table VI.14. Current Domestic Market Share (in percent)

Manufacturer	Before March 1988	1988	1989
Nikon	53.0	77.8	80.0
GCA	24.5	22.2	20.0
Canon	22.5	—	—
Nikon dominates the Korean market, trailed by Canon			

- Possibility of technical cooperation with Korean firms

— There is no possibility of arranging technical cooperation with Nikon or Canon. Nikon established a locally incorporated firm, Nikon Korea (50 [percent local] and 50 [percent foreign capital]), in March 1990. There is a possibility that GCA will open a subsidiary in Korea.

- Plan to promote technical cooperation

— The first plan: Samsung, GoldStar, Hyundai and specialized equipment manufacturers invest together in a joint venture with a foreign, technologically advanced company (market access assured).

— The second plan: Japanese firms that specialize in optics, such as Nikon and Canon (with ample capital) establish a joint venture with a foreign, technologically advanced company.

3) Diffusion Furnace

(a) Annual Plan for Domestic Production

Table VI.18. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Diffusion furnace (vertical type)	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		System performance analysis				
		Essential, specialized parts (for 4M-class chips)		Promote domestic production of parts (move up to 16M-class chips)		
Expected number of diffusion furnaces needed	35	40	50	40	20	
Goal for domestically produced diffusion furnaces	2	15	30	30	30	20
R&D cost of specialized parts (100 million won)	—	5	4	4	4	—
Estimated unit price	$500,000					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	

Major parts to be manufactured domestically	
Specialized parts	General-purpose parts
Heating element chamber	MFC/gas system
Process/temperature controller	Vacuum pumping system
Others	Auto motor loader/boat loader
	High purity valve

(b) Possibility for Technical Cooperation

Table VI.19. Current World Market Share (in $million)

Year	Market size	Market share (%)				
		TEL	SVG	Kokusai	BTU	Others
1988	269.5	39.3	18.1	9.1	—	33.5
1989	355.4	40.0	16.0	16.0	10.0	18.0

TEL became the world's largest supplier of diffusion furnaces because it is leading the Japanese market and selling in the United States through Varian.

SVG, which has the second largest market share, is popular in the United States and Europe.

BTU is slowly being pushed out by its Japanese competitors. Kokusai is successfully marketing its vertical furnace in Japan, but its American sales base is still weak.

Table VI.20. Current Domestic Market Share (in percent)

Year	Firm (share)			
Before March 1988	Thermco (40)	Bruce (20)	TEL (20)	Kokusai (12)
1988	Kokusai (35)	Bruce (33)	TEL (32)	
1989	Kokusai (50)	TEL (35)	SVG (15)	

American firms, such as SVG (Thermco) and BTU, were the leaders in the Korean market before 1988. However, Japanese firms, Kokusai and TEL, are leading the market since 1988, particularly for 1M DRAM production lines.

- Possibility for technical cooperation with Korean firms

— SVG (Thermco), BTU and Kokusai are likely to establish operations in Korea, depending on their marketing outlook.

— Toyoko (a supplier to NEC) plans to begin production [in Korea] through technical cooperation with Dongsan Hitek, thus increasing the possibility of domestic production [of diffusion furnaces] by 1991.

4) PE CVD

(a) Annual Plan for Domestic Production

Table VI.21. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
PE CVD	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		System performance analysis				
		Essential specialized parts (for 4M-class chips)		Promote domestic production of parts (move up to 16M-class chips)		
Expected number of PE CVD units needed	10	15	20	30	20	20
Goal for domestically produced PE CVD units	2	5	10	15	15	15
R&D cost of specialized parts (100 million won)	—	5	5	4	4	—
Estimated unit price	$600,000(as of 1989)					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	
Major parts to be domestically manufactured						
Specialized parts	General-purpose parts					
Electrode assembly/heater	Power supply					
Process/temperature controller	DC magnetron, RF generator					
Chamber	High vacuum system					
	Auto handling system					
	Automatic control system					

(b) Possibility for Technical Cooperation

Table VI 22. Current World Market Share (in $million)

Year	Market size	Market share (%)					
		AMT	ASM	Genus	Novellus	TEL	Others
1988	510.2	16	19	8	—	7	50
1989	755.8	26	13	9	7	6	39
Among AP CVD ($60 million), LP CVD ($300 million) and PE CVD ($400 million), PE CVD is the leading method.							
An American firm, AMT, is by far the dominant one. The market share of ASM is slowly decreasing. American firms hold 60 percent of the Japanese market for PE CVD.							
Another American firm, Genus, is the leader in the market for W-CVD.							
Market shares of Novellus, Kokusai and TEL for LP CVD are expanding.							

Table VI 23. Current Domestic Market Share (in percent)

Year	Total number of PE CVD units	Firm (share)		
Before March 1988	29	ASM (55.2)	AMT (41.4)	Others (3.4)
1988	10	AMT (100)		
ASM and AMT dominated the Korean market before 1988.				
After 1988, AMT's P5000 CVD completely dominated the market, and Genus monopolized the market for W-silicide deposition apparatus.				

- Possibility for technical cooperation with Korean firms

— AMT has no intention of agreeing to technical cooperation.

— Tokuda, Toyoku and ASM, which are medium-size Japanese firms, may be interested in technical cooperation. Some of them are likely to establish a jointly owned [Korean] company.

5) Ion Implanter

(a) Annual Plan for Domestic Production

Table VI.24. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Ion implanter (120XP, 300XP)	Assembly production of 1/4M-class chips (since 1988)		Assembly production of 16M-class chips			
		System performance analysis				
	Essential, specialized parts (for 4M-class chips)		Promote domestic production of parts (move up to 16M-class chips)			
Expected number of ion implanters needed	15	25	40	50	40	20
Goal for domestically produced ion implanters	15	20	25	40	30	20
R&D cost of specialized parts (100 million won)	3	4	3	5	5	—
Estimated unit price	$1.8 million (as of 1989)					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	
Major parts to be domestically manufactured						
Specialized parts	General-purpose parts					
Magnetic assembly	MFE/gas system					
Ion beam source	RF generator					
Isolation chamber	High vacuum system					
	Auto wafer handling system					
	Self-diagnostic system					

(b) Possibility for Technical Cooperation

Table VI 25. Current World Market Share (in $million)

Year	Market size	Market share (%)				
		Varian	Eaton	Nissin Electric	TEL	Others
1988	Low and Medium (123.9)	20.3	17.8	—	32.6	29.3
	High (248.5)	24.5	22.1	18.0	24.5	10.9
1989	Low, Medium (150.1)	38.0	19.0	—	16.0	27.0
	High (382.5)	27.0	19.0	—	18.0	36.0
American firms lead the world market.						
Varian and TEL/Varian hold about 50 percent of the world market, and Eton (U.S.) holds the second largest market share.						

Table VI 26. Current Domestic Market Share (in percent)

Equipment	Total number of ion implanters	Firm (share)	
Low-medium current	13	Varian (53.8)	Eaton (46.2)
High current	27	Varian (66.7)	Eaton (33.3)
Varian and Eaton monopolize the Korean market.			

- Possibility for technical cooperation with Korean firms

  —Varian already has a joint investment in Korea, which builds and sells high- and medium-current ion implanters. Major components in these implanters are domestically manufactured. Eaton is watching the situation.

- Goal for R&D financial support: Research on future-generation equipment left out from the 16/64M memory chip project
- Financial source:
  - — Basic industrial technology development fund administered by the Ministry of Trade and Industry.
  - — Special R&D project fund administered by the Ministry of Science and Technology.

Table VI.7. Promote as Part of the 16/64M Memory Chip Project

Equipment	1990	1991	1992	1993	1994	1995
PR coater/developer	Being promoted					
RIE	Being promoted					
ECR etcher	Being promoted					
ECR CVD			Being promoted			
Excimer laser stepper	Being promoted					

Table VI.8. Budget for the Above Plan (in 100 million won)

Year	1990	1991	1992	1993	1994	1995
Required R&D budget	19	17	12	12	—	—
Government support	19	17	12	12	—	—

- Goal for R&D financial support: Development of equipment for mass production of 64M-class chips
- Method for R&D financial support: Support as a national project guided by the government
- Financial source: Joint support by the Ministry of Trade and Industry, the Ministry of Science and Technology, and the Ministry of Communications

Table VI.9. Current Status and Future Plans to Promote the Development of Parts Common to Equipment

Equipment	1990	1991	1992	1993	1994	1995
High vacuum pump						
Two parts being plromoted						
MFC, etc.	Two parts being promoted					

Table VI.10. Budget for the Above Plan (in 100 million won)

Year	1990	1991	1992	1993	1994	1995
Required R&D budget	6	30	40	50	50	30
Government support	6	20	25	30	30	20

* Development topics in 1993 and afterward will be selected later.

- Method for R&D financial support: Announce basic industrial technology development projects
- Financial source: Basic industrial technology development fund

Assembly Production through Technical Cooperation

Table VI.11. Status of Technical Cooperation

Equipment	Status
Stepper	No difficulty anticipated in establishing technical cooperation
Dry etcher	No difficulty anticipated in establishing technical cooperation
Diffusion furnace	Joint domestic production planned in 1991
PE CVD	
Ion implanter	Already in production
Sputterer	Varian plans production in 1991
Memory tester	Joint domestic production planned in 1991
PR stripper	Production planned in 1991

2) Dry Etcher

(a) Annual Plan for Domestic Production

Table VI.15. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Dry etcher	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		System performance analysis				
Expected number of dry etchers needed	10	30	40	60	30	26
Goal for domestically produced dry etchers	2	10	15	30	20	20
R&D cost of specialized parts (100 million won)	—	15	15	14	14	—
Estimated unit price	$700,000					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	
Major Parts to be Domestically Manufactured						
Specialized parts	General-purpose parts					
Electrode system (cathode/anode)	RF generator					
Repeat assembly	High vacuum system					
Reactor assembly/RF match assembly	MFC/Gas system					
Pneumatic assembly	Auto wafer handling system					
Top plate assembly	Self-diagnostic system					

(b) Possibility for Technical Cooperation

Table VI.16. Current World Market Share (in $million)

Year	Market size	Market share (%)				
		AM	LAM	TEL	Tegal	Others
1988	625.6	35	12	10	7	36
1989	784.5	31	14	13	7	35
ATM leads the market ahead of LAM.						
TEL is growing fast and nibbling into LAM's share in Japan and Korea (accumulated technology through technical cooperation with LAM). TEL is trying to sell in the United States through Varian.						

Table VI.17. Current Domestic Market Share (in percent)

Year	Total number of dry etchers	Firm (share)		
Before March 1988	250	LAM (46.8)	AMT (24.4)	Drytek (24.4)
1988	57	LAM (40.4)	TEL (40.4)	AMT (10.5)
LAM was the leading supplier before 1988.				
TEL has led the Korean market since 1988; LAM's share is slowly decreasing; and AMT is gaining.				

- Possibility for technical cooperation and current status

  — Technical cooperation with TEL or AMT is unlikely.

  — In the case of LAM, domestic production is possible if market share is secured.

  — Technical cooperation with Tokuda or Toyoku, both of which are medium-size Japanese firms, may be possible.

6) Sputterer (P CVD)

(a) Annual Plan for Domestic Production

Table VI.27. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Sputterer (P CVD)	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
	System performance analysis					
		Essential specialized parts (for 4M-class chips)	Promote domestic production of parts (move up to 16M-class chips)			
Expected number of sputterers needed	8	15	20	30	20	15
Goal for domestically produced sputterers	5	8	15	20	15	10
R&D cost of specialized parts (100 million won)	—	8	8	6	6	—
Estimated unit price	$1.8 million					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	
Major parts to be domestically manufactured						
Specialized parts	General-purpose parts					
Sputtering gun	Power supply					
Vacuum chamber	DC magnetron, RF generator					
Module assembly	High vacuum pumping system					
Process chamber	Auto handling system					
	Automatic control system					

(b) Possibility for Technical Cooperation

Table VI.28. Current World Market Share (in $million)

Year	Market size	Market share (%)				
		Varian	MRC	Anelva	Ulvac	Others
1988	366.4	25	19	16	12	28
1989	415.5	23	21	14	14	28
American firms, such as Varian and MRC, lead the world market.						
Japanese firms, such as Ulvac and Anelva, are gaining.						

Table VI.29. Current Domestic Market Share (in percent)

Year	Total number of sputterers	Firm (share)		
Before March 1988	59	Varian (72.9)	MRC (22.0)	Anelva (5.1)
1988	57	Varian (46.7)	MRC (40.0)	Anelva (13.3)

- Possibility for technical cooperation with Korean firms
  - — Domestic production is being carried out by Varian Korea, a joint venture with Varian.
  - — MRC, a competitor, may agree to domestic production.

7) Memory Tester

(a) Annual Plan for Domestic Production

Table VI.30. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Memory tester	Begin assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
			System performance technical/comprehensive analysis			
				Promote independent domestic technology development		
				Develop own model		
Expected number of memory testers needed	15	20	30	45	30	15
Goal for domestically produced memory testers	5	10	10	20	20	10
R&D cost of specialized parts (100 million won)	—	6	6	5	5	—
Estimated unit price	$600,000					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	
Major parts to be domestically manufactured						
Specialized parts	General-purpose parts					
Pattern generator	Software					
Color graphic monitor	Graphic analysis					
Host processor	Failure analysis					
Trimming generator	Computer for automatic control					
Test head assembly	Microprocessor application technology					
Modulation device						

(b) Possibility for Technical Cooperation

Table VI.31. Current World Market Share (in $million)

Year	Equipment	Market share (%)			
		Advantest	Ando	Teradyne	Others
1988	Logic	29.7	13.5	—	56.8
	Linear	7.4	—	29.1	63.5
	Memory	42.6	12.9	11.5	33.0
Japanese firms hold 55 percent of the world market.					
Japanese firms are stronger than American firms in the world market.					

Table VI.32. Current Domestic Market Share (in percent)

Year	Total number of memory testers	Firm (share)			
Before March 1988	306	Minato (26.1)	Teledyne (13.1)	Ando (12.4)	Advantest (12.?)
1988	70	Minato (42.9)	Ando (20.0)	Advantest (8.5)	
Minato holds the largest share of the Korean market, although Advantest and Ando are the top two in the world market.					
Megatest leads the Korean market in wafer testers.					

- Possibility for technical cooperation with Korean firms

— Ando is considering domestic production.

— Advantest and Minato are unlikely to try domestic production.

8) Test Handler

(a) Annual Plan for Domestic Production

Table VI.33. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Test handler	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		System performance analysis				
		Essential, specialized parts (4M-class chips)	Promote domestic production of parts (move up to 16M-class chips)			
Expected number of test handlers needed	20	50	60	80	50	20
Goal for domestically produced test handlers	10	20	40	60	50	20
R&D cost of specialized parts (100 million won)	—	1	1	—	—	—
Estimated unit price	$120,000					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	

Major parts to be domestically manufactured	
Specialized parts	General-purpose parts
Contact assembly (ZIP, SOJ, DIP)	Stepping motor
Quad loader (rapid)	High-power motor driver
Hot chamber	Power supply assembly
Input and sorter chain assembly	

(b) Possibility for Technical Cooperation

- Current world market share

— It is difficult to determine market shares of individual firms.

—Symtek, Hitachi and MCT are market leaders.

—Japanese manufacturers hold 60 percent of the world market.

Table VI.34. Current Domestic Market Share (in percent)

Year	Total number of test handlers	Firm (share)			
Before March 1988	220	Symtek (54.5)	Hitachi (18.2)	MCT (18.2)	TESEC (9.1)
1988	230	Symtek (47.8)	Hitachi (26.1)	MCT (21.7)	TESEC (4.4)
Symtek is strong in test handlers for memory chips; it held about one-half of the Korean market.					
MCT is strong in test handlers for applications other than memory chips.					

- Possibility for technical cooperation with Korean firms

— Symtek is engaged in domestic production through technical cooperation.

9) Wafer Probe Station

(a) Annual Plan for Domestic Production

Table VI.35. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
Wafer probe station (fully automated)	Promote assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		System performance analysis				
		Essential, specialized parts (4M-class chips)		Promote domestic production of parts (move up to 16M-class chips)		
Expected number of wafer probe stations needed	40	70	90	120	80	40
Goal for domestically produced wafer probe stations	20	30	50	80	60	40
R&D cost of specialized parts (100 million won)	—	2	2	—	—	—
Estimated unit price	$100,000					
Main applications		1/4M-class chips	4/16M-class chips		16M-class chips	

Major parts to be domestically manufactured	
Specialized parts	General-purpose parts
Ring carrier	Auto align processor/camera
Probe control logic/power supply control	Linear motor
POGO pin array assembly	Auto wafer handling system

(b) Possibility for Technical Cooperation

Table VI.36. Current World Market Share (in $million)

Year	Market size	Market share (%)			
		TEL	General Sig.	Tokyo Seimitsu	KLA
1988	213.1	47	24	14	11
1989	276.4	45	22	15	14

TEL expanded rapidly and now holds 45 percent of the world market, manufacturing about 120 wafer probe stations per month. EG competes against TEL in the American market as well.

Table VI.37. Current Domestic Market Share (in percent)

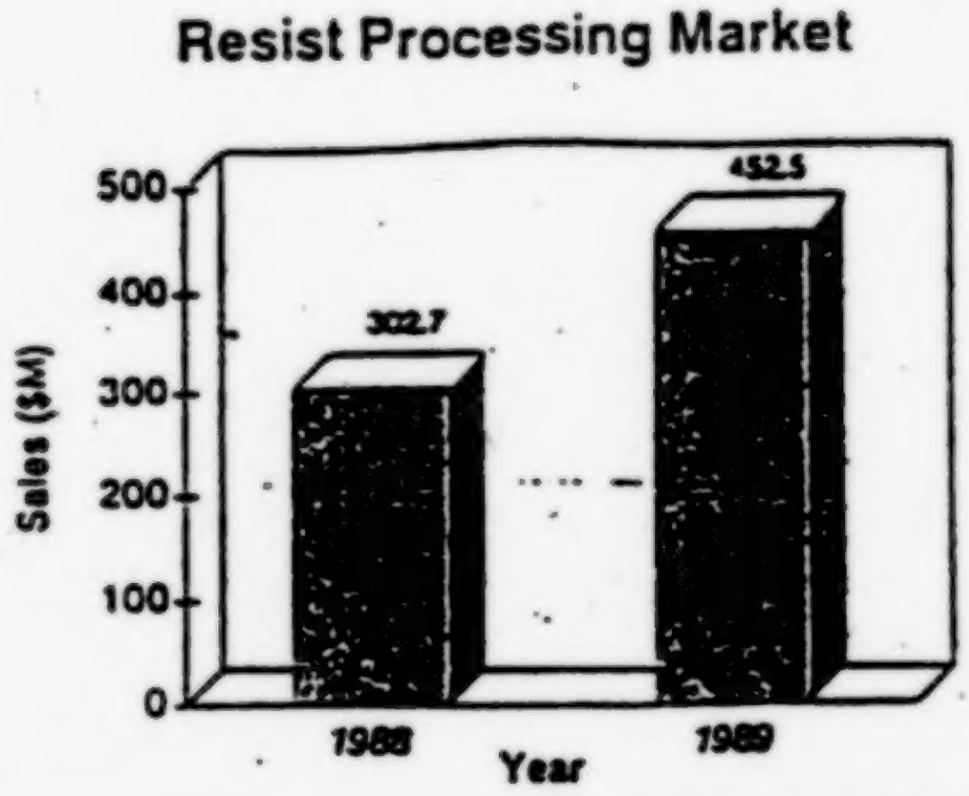
Year	Total number of wafer probe station	Firm (share)		
Before March 1988	250	GS (55)	TEL (35)	Tokyo Seimitsu (10)
1988 to early 1989	170	TEL (55)	GS (45)	

- Possibility for technical cooperation with Korean firms

— TEL holds 55 percent of the world market; it is not interested in manufacturing in Korea.

— GS is hesitant about production in Korea because of economic viability.

— Independent domestic development should be promoted (in 1990).



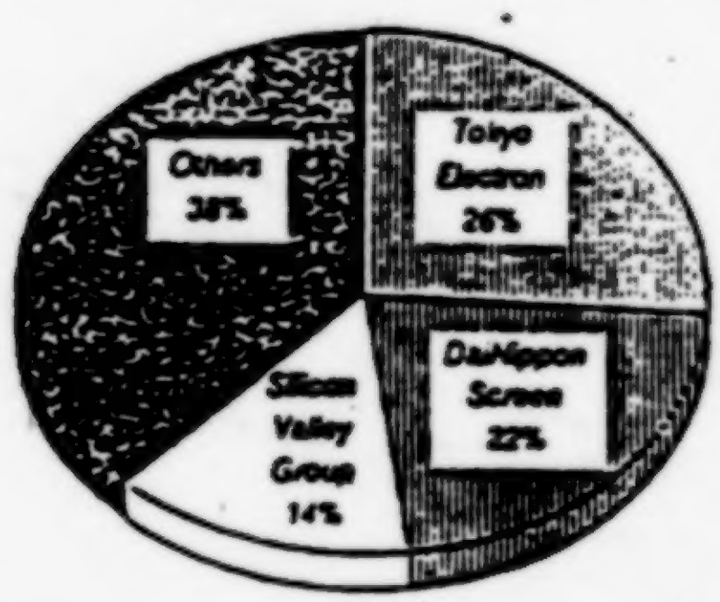


Figure VI.1. Current World Market Share

10) PR Stripper

(a) Annual Plan for Domestic Production

Table VI.38. Annual Plan for Domestic Production

Year	1990	1991	1992	1993	1994	1995
PR Stripper	Assembly production of 1/4M-class chips			Assembly production of 16M-class chips		
		Promote domestic production of essential, specialized parts (4M-class chips in 1991 and 1992, and 16M-class chips in 1993 and 1994)				
Expected number of PR strippers needed	20	40	50	60	60	60
Goal for domestically produced PR strippers	—	40	45	55	55	60
R&D cost of specialized parts (100 million won)	—	2	1	2	2	—
Main applications	1/4M-class chips		4/16M-class chips		16M-class chips	
Major components	RF generator					
	Vacuum					
	Quartz chamber					
	Loading mechanism (robotics)					
	Controller					
	Gas control and ETC					

(b) Possibility for Technical Cooperation

- Kumyong Trading plans to begin domestic production in 1991 in a joint venture with Japan's PSK.

Promotion of Basic Technology Development Projects

(1) Diffusion Furnace

Table VI.39. Development Plan for Diffusion Furnace

Equipment	1990	1991	1992	1993	1994	1995
Diffusion furnace	Develop mass production model		Supplement and improve equipment performance			
Anticipated number of diffusion furnaces needed (each)	10	20	30	40	30	10
Goal for domestically produced diffusion furnaces (each)	—	5	10	20	20	10

Table VI.39. Development Plan for Diffusion Furnace (Continued)

Equipment	1990	1991	1992	1993	1994	1995
Diffusion furnace	**Develop mass production model**		**Supplement and improve equipment performance**			
Anticipated R&D cost (100 million won)	3	3	—	—	—	—
Major specifications	Wafer size: 4-6 inches					
	Temperature range used: 200-1,200°C					
	Temperature flat zone: 800 mm					
	Temperature stability: +/-0.25°C					
	Time for raising temperature (room temperature to 1,200°C): 60 minutes					
	Time for cooling (1,200°C to 600°C): 150 minutes					
Current status	Selected and promoted as a 1990 basic technology project					
Participant	I.C. TEC (Taegu Univ.)					

(2) LP CVD (Vertical)

Table VI.40. Development Plan For LP CVD

Equipment	1990	1991	1992	1993	1994	1995
LP CVD (Vertical)	**Develop mass production model**		**Supplement and improve equipment performance**			
Anticipated number of LP CVD units needed (each)	10	15	20	30	20	10
Goal for domestically produced LP CVD units (each)	—	5	10	15	15	10
Anticipated R&D cost (100 million won)	3	3	2	2	—	—
Major specifications	Throughput (wafers/batch)	200 (4.5 inches), 100 (6 inches)	200 (4.5 inches), 100 (6 inches)	50	50	50
	Evaporation rate (A/min)	100	50	100	100	100
	Thickness uniformity: Within wafer	+/-2%	+/-2%	+/-3%	+/-3%	+/-3%
	Thickness uniformity: Wafer to wafer	+/-3%	+/-3%	+/-6%	+/-6%	+/-6%
	Thickness uniformity: Run to wafer	+/-3%	+/-3%	+/-6%	+/-6%	+/-6%
Current status	Selected and promoted as a 1990 basic technology project					
Participant	Dongil Commerce					

(3) Dry Etcher

Table VI.41. Development Plan for Dry Etcher

Equipment	1990	1991	1992	1993	1994	1995
Dry etcher	**Develop mass production model**		**Supplement and improve equipment performance**			
Anticipated number of dry etchers needed (each)	10	15	15	20	15	10
Goal for domestically produced dry etchers (each)	—	5	7	10	10	10

Table VI.41. Development Plan for Dry Etcher (Continued)

Equipment	1990	1991	1992	1993	1994	1995
Anticipated R&D cost (100 million won)	3	2	2	2	—	—
Category	Si, N, etcher		PAD etcher			
			LTO		Resin	
Wafer diameter	4-6 inches		4-6 inches		4-6 inches	
Etching rate (A/min)	> 1,500		> 6,000		> 6,000	
Uniformity, within wafer	< +/-5%		< +/-5%		< +/-5%	
Uniformity, wafer to wafer	< +/-5%		< +/-5%		< +/-5%	
Selectivity: To oxide	> 5:1					
Selectivity: To PR	> 2:1		> 3:1		> 3:1	
Selectivity: To Poly [polymers?]			> 3:1		> 3:1	
CD loss	< 0.05 μm		< 0.2 μm		< 0.2 μm	
Current status	Selected and promoted as a 1990 basic technology project					
Participants	Fine Semiconductor Technology, Chaelim Engineering, Chein Technic, Seoul National Univ.					

(4) Logic Tester

Table VI.42. Development Plan for Logic Tester

Equipment	1990	1991	1992	1993	1994	1995
Logic tester	Technology analysis					
		Development according to function				
				Comprehensive system development		
Anticipated number of logic testers needed (each)	30	40	50	60	50	30
Goal for domestically produced logic testers (each)	—	—	10	20	30	20
Anticipated R&D cost (100 million won)	2	3	3	3	—	—
Major development topics	Real time pattern generation function					
	Direct transmission of design data from CAD to tester					
	Graphic debugger function					
	For 8/16/32-bit CPU test					
	Test rate: Over 60 MHz					
	Accuracy: 250 Ps					
Current status	Selected and promoted as a 1990 basic technology project					
Participants	Far East Numeric, Kyongbuk Univ.					

(5) MBE [Molecular beam epitaxy]

Table VI.43. Development Plan for MBE

Equipment	1990	1991	1992	1993	1994	1995
MBE (estimated unit price: $700,000)	Promote independent development					
Anticipated number of MBE's needed (each)	2	2	2	5	5	5
Goal for domestically produced MBE's (each)	—	—	2	3	3	3
Anticipated R&D cost (100 million won)	5	5	5	—	—	—
Main consumers	Research centers of universities, semiconductor firms					
Major development topics	Chamber composition			Specimen thermal processing and analysis chamber		
	Epitaxial growth chamber			Thermal processing temperature: 800+1°C		
	Specimen thermal processing and analysis chamber			Atmospheric gas system: Volatile element source		
	Specimen in/out chamber					
	Chamber vacuum: 10 torr			Specimen in/out chamber		
	Epitaxial growth chamber			Specimen extraction, loading		
	Number of cells: 8			Expitaxy specifications		
	Molecular beam cutoff shutters: 9			Thickness uniformity: +/-5%		
	Rheed (10 KeV)			Doping uniformity: +/-10%		
Current status	Selected and promoted as a 1990 basic technology project					
Participants	KAIST, Dongil Commerce (joint development by industry, academia and research laboratories)					

(6) Burn-In System

Table VI.44. Development Plan for Burn-In System

Equipment	1990	1991	1992	1993	1994	1995
Burn-in system (estimated unit price: $100,000)		Promote independent development				
			Supplement and improve equipment performance			
Anticipated number of burn-in systems needed (each)	10	20	30	50	30	10
Goal for domestically produced burn-in systems (each)	—	5	10	30	20	10
Anticipated R&D cost (100 million won)	—	2	2	—	—	—
Major development topics	Temperature range: Room temperature-150°C					
	Temperature uniformity: +/-3°C					
	Temperature uniformity at 150°C (empty): +/-0.7°C					
	Temperature rise/fall time: (25°C to 125°C) in 40 minutes (program method)					
	Recirculation fan capacity: 2600 CFM [cubic feet/minute]					
Current status	Selected and promoted as a 1990 basic technology project					
Participant	Dongil Engineering					

(7) Wafer Probe Station

Table VI.45. Development Plan for Wafer Probe Station

Equipment	1990	1991	1992	1993	1994	1995
Wafer probe station (fully automated)		Develop mass production model				
				Supplement equipment performance		
Anticipated number of wafer probe stations needed (each)	40	70	90	120	80	40
Goal for domestically produced wafer probe stations (each)	20	30	50	80	60	40
Anticipated R&D cost (100 million won)	—	2	2	—	—	—
Major applications		1/4Mchips	4/16Mchips		16Mchips	
Remarks (major components to be produced domestically)	Specialized components					
	Ring carrier					
	Probe control logic/power supply control					
	General-purpose components					
	Auto align processor/camera					
	Linear motor					
	Monitor/keyboard					
	Auto wafer handling system					
Current status	Will be promoted as a 1991 development project					

(8) Die Bonder

Table VI.46. Development Plan for Die Bonder

Equipment	1990	1991	1992	1993	1994	1995
Die bonder (automated)		Develop mass production model (in-line system)				
				Supplement and improve equipment performance		
Anticipated number of die bonders needed (each)	50	60	75	85	70	50
Goal for domestically produced die bonders (each)	15	30	45	60	50	40
Anticipated R&D cost (100 million won)	—	2	2	—	—	—
Major specifications	Bonding speed: 0.5-0.8 sec/die					
	Bonding head: Digital method					
	Bonding accuracy: x,y: 0.1 mm; O: 3°					
	Wafer size: Maximum 8 inches					
	Feeder: Flexible frame feeder					
	Bonding method: Epoxy resin adhesive					
Current status	Will be promoted as a 1991 development project					

(9) Wire Bonder

Table VI.47. Development Plan for Wire Bonder

Equipment	1990	1991	1992	1993	1994	1995
Wire bonder (automated)		Develop mass production model (in-line system)				
				Supplement and improve equipment performance		
Anticipated number of wire bonders needed (each)	160	200	230	270	250	150
Goal for domestically produced wire bonder (each)	30	70	140	200	120	—
Anticipated R&D cost (100 million won)	—	2	2	—	—	—
Major specifications	Bonding speed: 0.18 sec/wire					
	Recognition speed: 0.25 sec					
	Pattern recognition resolution: 5 μm					
	X-Y table resolution: 2 μm/pulse, DC servo motor drive					
	Bonding program: 230 wires x 8 ICs					
	Feeder: Flexible frame feeder					
	Suitable for multiple types, small quantity production					
Current status	Will be promoted as a 1991 development project					

(10) Marking Machine

Table VI.48. Development Plan for Marking Machine

Equipment	1990	1991	1992	1993	1994	1995
Marking M/C (estimated unit price: $70,000)	Develop mass production model					
Anticipated number of marking machines needed (each)	10	15	20	30	20	10
Goal for domestically produced marking machines (each)	2	7	10	20	15	10
Anticipated R&D cost (100 million won)	1	—	—	—	—	—
Major specifications	Printing area: 30 by 250 maximum					
	U.P.H.: 1 strip X unit x 3 sec X 20 X 60					
	Maximum S.P.M. of marking head and system: 60					
	Applicable PKG: P-DIP, SOIC, PLCC, PQFP, SIP, ZIP, etc.					
Current status	Will be promoted as a 1991 development project					

(11) Automated Wet Station

Table VI.49. Development Plan for Automated Wet Station

Equipment	1990	1991	1992	1993	1994	1995
Automated wet station (estimated unit price: $500,000)	Develop mass production model		Supplement and improve equipment performance (dry station)			
Anticipated number of automated wet stations needed (each)	20	30	40	50	40	20
Goal for domestically produced automated wet stations (each)	2	10	20	30	30	20
Anticipated R&D cost (100 million won)	2	—	5	5	—	—
Major specifications	Main unit: Minimum exhaust attachment open type					
	Carrier: 4-6 inches					
	Processing tank: Teflon and quartz					
	Piping materials: PVDF PFC and clean PVC					
	Filter: 0.2 μm					
	Resistivity: Over 16 mΩ-cm					
Current status	Selected and promoted as a 1990 basic technology project					
Participant	Hanyang Machinery					

Table VI.50. Equipment Being Promoted for Independent Domestic Development

Equipment	Current status
Diffusion furnace	Adopted as a 1990 development project. Participant: I.C. TEC
LP CVD	Adopted as a 1990 development project. Participant: Dongil Commerce
Dry etcher	Adopted as a 1990 development project. Participant: Chein Technic
MBE	Adopted as a 1990 development project. Participant: Dongil Commerce
Logic tester	Adopted as a 1990 development project. Participant: Far East Numeric
Wafer probe	Will be promoted as a 1991 development project.
Burn-in system	Development completed, test product being evaluated.
Die bonder (automated)	Performance upgraded to an automated system
Wire bonder (automated)	Performance upgraded to an automated system
Automated molding machine	Adopted as a 1990 development project. Participant: Hanmi Metal Dies
Laser marking machine	Will be promoted as a 1991 development project.
Wet station	Adopted as a 1990 development project. Participant: Hanyang Machinery

2. Establishment of Comprehensive Support System to Effectively Promote Domestic Production Plan

During the five-year plan for domestic production of semiconductor equipment, the government will survey required technology every year to identify and support essential technology projects.

(a) Effective Use of Government's Technology Development Support Fund

Table VI.51. Total R&D Funding Needed and Government Support (in 100 million won)

Category		1990	1991	1992	1993	1994	1995	Total
Required R&D funding		48	108	132	145	128	82	643
Government support	Total	47	80	96	105	89	57	474
	Basic technology fund	30	40	44	52	49	33	248
	Industrial development fund (Medium and small business structure adjustment fund)	2	26	32	28	27	20	135
	Support from other government agencies*	15	14	20	25	13	4	91

* The Ministry of Science and Technology (Special R&D Project Fund); the Ministry of Communications (Fund for Korea Telecommunications Authority).

- Industrial Development Fund and Medium and Small Business Structure Adjustment Fund

Support objective:

— Domestic production of essential parts for assembly production through technical cooperation.

Support method:

— Announce and support projects for domestic production of machinery, parts, and raw materials.

Table VI.52 R&D Budget Needed and Government Support (in 100 million won)

Year	1990	1991	1992	1993	1994	1995	Total
R&D budget needed	3	37	45	40	38	30	193
Government support	2	26	32	28	27	30	135

In 1990, 12 projects (1.4 billion won) are supported from the basic industrial technology development fund.

- Support for large firms' technology development funds

— Support joint development fund for advanced industrial technology from the industrial development fund.

— Support advanced industrial development fund.

- Support special R&D project fund through the Ministry of Science and Technology

— Provide joint support for projects under government guidance.

- Support basic industrial technology development project fund

Support objective:

— Select and promote equipment for independent domestic development.

— Develop parts shared among semiconductor manufacturing equipment.

— Carry out 16/64M DRAM projects.

— Select R&D projects to be promoted under government guidance.

Table VI.53. R&D Budget Needed and Government Support (in 100 million won)

Year	1990	1991	1992	1993	1994	1995	Total
R&D budget needed	45	71	87	105	90	52	450
Government support	30	40	44	52	49	33	248

(b) Training Expert Manpower

(1) Training Experts in Manufacturing Technology

- Send more people to partners in advanced technology cooperation for training.

— This strategy should be used in an early stage where there is an absolute shortage of experts who could train others in equipment manufacturing technology.

— Train specialists on manufacturing technology for each type of equipment through overseas training supported by individual manufacturers.

— Translate all technical publications into Korean and distribute through Semiconductor Equipment Association.

- In the later stage (1993-1994) of this domestic production plan, comprehensive training will be provided to train manufacturing technology specialists by using domestic experts as instructors through a semiconductor equipment training center.

(2) Improve Technical Manpower Quality

- Train technical manpower through the Semiconductor Research Institute of Seoul National University

— Teach basic and operating technologies for semiconductor equipment.

— Teach semiconductor processing technology.

— Practice operation of semiconductor equipment.

- Establish a semiconductor equipment training center as a subsidiary of the Semiconductor Equipment Association to train manpower.

— Establish the training center by June 1991 as part of the Semiconductor Equipment Association.

— Personnel to be trained: Operation and maintenance personnel of users of semiconductor equipment; manufacturing and A/S [assembly system?] personnel of equipment manufacturers; staff of business-supported laboratories.

— Use experts in universities and research laboratories (Manufacturing Technology Research Institute, etc.) as instructors.

(3) Provide Government Support for Manpower Training (Send to Seoul National University for Training)

- Financial resource: Manpower training fund from the medium and small business structure adjustment fund.

- Support type: Loans to cover manpower training cost and basic salaries and benefits.

- Support conditions: Annual interest of 7.5 percent for 3 years (including one year to be kept in an account); maximum of 10 million won; up to 100 percent of required cost.

- Support organization: Comply with manpower training fund support rules; the Semiconductor Equipment Association will collect all applications and apply to the Medium and Small Business Promotion Corporation.

(c) Strategy to Utilize Manpower from Government Financed and Academic Research Laboratories

- Strengthen joint development system among industry, academia and research laboratories.

— Survey the status of semiconductor equipment experts in domestic universities and government financed laboratories and establish a database (complete by the end of 1990).

— Support efficient liaison between domestic experts and businesses participating in domestic production of [semiconductor] equipment and related parts (to be started in 1991).

- Conduct research on equipment based on future-generation concepts and transfer technology to industry.

— Area to be emphasized: Lithography equipment.

This is a key to higher-density integration, which cannot be achieved with known concepts.

The need for R&D in this area is understood, but individual businesses are reluctant to carry out own R&D because of excessive R&D cost and unclear marketing prospects.

— University and government financed laboratories will carry out research and then jointly develop mass production equipment with industry.

(d) Support Site Procurement by Semiconductor Equipment Manufacturers

- The semiconductor equipment industry was selected as one of the industries allowed to secure sites in the Songtan and Chonan II industrial parks at the eighth meeting of the Industrial Policy Council (on 2 November 1989).
- These two industrial parks will be promoted as industrial parks for the semiconductor equipment industry.

— The Semiconductor Equipment Association and the Semiconductor Research Cooperative (Semiconductor Joint Research Laboratory) will move to the Chonan II industrial park.

— Status of manufacturers located in the industrial parks:

Songtan industrial park: 7 companies including Daebo Precision (11,000 pyong [about 9 acres])

Chonan II industrial park: 22 companies including Taesok Machinery (36,000 pyong [about 29 acres]).

— Aggressive solicitation for new businesses to locate in the industrial parks.

- Support for employee housing

— Housing support will be provided until 1992, when most businesses are expected to have moved into the parks.

(e) Encourage Activities of the Semiconductor Equipment Association

- The association was established on 3 November 1988.
- Projects of the association to be emphasized in the future:

— Promotion of the 5-year plan for domestic production of semiconductor equipment.

— Establish manpower training plan for the semiconductor equipment industry.

— Establish and operate a committee to promote domestic production of semiconductor equipment.

— Survey imported equipment and make the data public.

— Build a database of expert manpower for semiconductor equipment.

— Exchange information with foreign semiconductor equipment associations (SEMI in the United States and SEAJ in Japan).

— Dispatch delegations to advanced countries to seek technical cooperation.

(f) Promote Development of Sample Equipment Using the Industrial Development Fund

- At present, participants of projects to develop sample products in machinery and electronics are not interested in entering the field of semiconductor equipment.
- The Semiconductor Equipment Association should be appointed as the sole agent to handle matters concerning semiconductor equipment.

— Support the association to promote the semiconductor equipment industry.

— Necessary to provide more than 2 billion won per year from the industrial development fund.

(g) Jointly Establish a Specialty Company to Manufacture Essential Equipment

- Targeted equipment: Equipment essential in future-generation concepts that may be used as [competitive] weapons by advanced countries (such as steppers).
- Plans for establishing a specialty company

Plan 1

— Establish a company as a joint investment by semiconductor manufacturers (Samsung Electronics, Hyundai Electronics, GoldStar Electron, etc.) and semiconductor equipment manufacturers. The company can further invite a reputable foreign company to enter into technical cooperation (or a joint venture). This will provide a secure market.

Plan 2

— Japanese firms specializing in optics (Nikon, Canon) may be invited to invest in Korea under technical cooperation (or joint investment) with a reputable foreign company. This will provide a secure market and secure funding. Nikon established Nikon Korea (50% Japanese and 50% Korean owned) in March 1990.

(h) Establish a Comprehensive Semiconductor Equipment Laboratory

- Establish a semiconductor equipment laboratory using the Semiconductor Equipment Research Cooperative and Manufacturing Technology Research Institute as a base.
- Location: Chonan II industrial park
- Date: 1991
- Operational Plan:

— Operate as a subsidiary of the Semiconductor Equipment Association.

— The laboratory will study four research areas:

The first area: Study wafer processing equipment.

The second area: Study assembly equipment.

The third area: Study test equipment.

The fourth area: Study peripheral equipment.

- Required fund and other details of the laboratory plan will be worked out during 1990.

(i) Establish a "Committee to Promote Domestic Production of Semiconductor Equipment"

- Objectives and roles:

— Establish well-organized cooperative system between the users and equipment manufacturers

Utilize as an organization through which to exchange opinions.

Strengthen horizontal cooperative system.

— Establish joint response system to secure and connect with firms with advanced technologies.

Induce domestic production by semiconductor equipment manufacturers in advanced countries.

Support connection to capable manufacturers through technical cooperation.

— Evaluate, modify, and revise the five-year plan for domestic production of semiconductor equipment.

- Committee membership

— Officers of user firms and [equipment] manufacturers.

— Experts from government financed laboratories and university laboratories.

— President of the Semiconductor Equipment Association.

— Board chairman of the Semiconductor Research Cooperative.

— Director of the Electronic and Electric Industry Bureau, the Ministry of Trade and Industry.

- The Semiconductor Equipment Association will serve as the business office of the committee.

(j) Dispatch a "Delegation to Promote Technical Cooperation with Advanced Countries"

- Objective:

— The delegation will try, actively and aggressively, to secure partners for technical cooperation to achieve domestic production of semiconductor equipment that require technical cooperation.

- Date:

— The delegation will use the largest exhibits in semiconductor equipment, "Semicon West" and "Semicon Tokyo."

- Composition:

— Members of the "Committee to Promote Domestic Production of Semiconductor Equipment."

— Officers of relevant equipment users and manufacturers.

- Preparation:

— The Semiconductor Equipment Association will prepare the itinerary.

(k) Strengthen Domestic and Overseas Public Relations Activities

- Assist in the formation of a nationwide understanding for the necessity and inevitability of domestic production of semiconductor equipment.

— Encourage investments by semiconductor equipment manufacturers.

— Encourage semiconductor manufacturers to use domestically manufactured equipment.

— Strengthen research on semiconductor equipment by relevant laboratories.

- Induce domestic investments by firms in advanced countries.

— Attempt to secure partners for technical cooperation.

- Actively utilize "Semicon Korea."

— Strengthen public relations activity on domestic investment conditions to foreign firms.

— Report current status of domestic semiconductor equipment industry in meetings.

(l) Study Supporting Method to Expand Use of Domestically Manufactured Equipment (Support for Users)

- Allow temporary tax deduction of invested amount

— Allow 10 percent of the investment made to acquire new, domestically manufactured equipment for direct use in manufacturing to be deducted from the corporate tax of the year such equipment were purchased. (A deduction of 3 percent is allowed for imported equipment.)

- Reduce import duty on parts for semiconductor equipment

— Present rule: The basic import duty rate for semiconductor equipment is 13 percent. However, duty for advanced equipment is reduced (by 45 percent in 1990) and the actual duty rate is 5.85 percent, while the duty for equipment parts remains at 13 percent.

- Difficulties: Inverted duty rates exist between semiconductor equipment and their parts. The prices of domestically produced equipment will not be competitive with a 13 percent duty applied to their imported parts. Most essential parts of major processing equipment targeted in the 5-year domestic production plan in its early stage will be imported and assembled in Korea.
- Reduce depreciation age limit for durable assets.

— The current rule sets the depreciation of semiconductor equipment at 6 years. This age limit should be reduced to 4 years to stimulate facility investments.

Appendix

A. Members of the Survey Committee on Industrial Technology Needs of the Nineties

Surveyed topic: Semiconductor equipment

Committee title: Survey Committee on Semiconductor Technology Needs

Official in charge: Pongsik SONG

Table A. Members of the Survey Committee on Semiconductor Technology Needs

Category		Affiliation	Title	Name	Telephone
Chairman		Electronics & Telecommunications Research Inst.	Section leader	Powu KIM	(042) 820-6801
Members		Manufacturing Technology Research Inst.	Section leader	Insop SONG	8601-402
		Manufacturing Technology Research Inst.	Ph.D.	Kangho AN	574-5946
		Kyongbuk Univ.	Professor	Chonghyon YI	(053) 950-5519
		Samsung Electronics	Director	Sinyong PAK	751-3941
		Hyundai Electronics	Director	Ponghak PAEK	741-0661
		GoldStar Electron	Director	Taeho SONG	575-5811
		Daewoo Communications	Division chief	Chanhyong KANG	866-9037
		Dongil Commerce	President	Wonho PAK	546-5501
		Mirae Industries	President	Munsul CHONG	764-4853
		Varian Korea	President	Songgi SO	867-6076
		Taesok Machinery	Director	Chungil CHOE	(546) 461-7491
		Fine Semiconductor	President	Myongsik CHANG	752-4632
		Hanmi Metal Dies	President	Nogwon KWAK	741-3271
		Semiconductor Equipment Assoc.	President	Chirak KIM	576-3472
		Semiconductor Equipment Research Cooperative	Chairman	Chaewuk KIM	862-4670
Total				16	
Managers		Semiconductor Equipment Assoc.	Division chief	Hyonchang IM	576-3472
		Semiconductor Equipment Research Cooperative	Bureau chief	Sungwu KWON	576-3472
Working team	Team leader	Electronic Parts Division, Ministry of Trade & Industry	Section leader	Pongsik SONG	500-2515
	Team member	Electronic Parts Division, Ministry of Trade & Industry	Engineer	Puchol KIM	500-2515
		Korea Inst. for Economics & Technology	Researcher	Pyonghon SONG	962-6211
		Samsung Electronics	Division chief	Chinsu HAN	751-2114
		GoldStar Electron	Division chief	Sungyong PAK	575-5811
		Hyundai Electronic	Deputy division chief	Chaewon PAENG	741-0601
		Semiconductor Research Cooperative	Section chief	Chaebong PAN	554-4686

B. Meetings Held by the Survey Committee on Industrial Technology Needs

Table B. Committee Meeting Log

Dates	Number of participants	Major topics discussed
14 June 1990	20	Committee composition; survey plan and tabular format
29 June 1990	8	Discuss and revise interim report
25 July 1990	8	Discuss and revise interim report
5 September 1990	20	Discuss and revise final report

C. Survey Participants

Table C. Survey Participants. [All dates are in 1990; MTI = Ministry of Trade and Industry.]

Firm	Items surveyed	Firm location	Survey date	Surveyor		
				Affiliation	Title	Name
Varian Korea	Semiconductor equipment	Ansan, Kyonggi-do	18 June	MTD	Engineer	Puchol KIM
Hanyang Machinery				Samsung Electronics	Division chief	Chinsu HAN
Sinsong Engineering		Ansan, Kyonggi-do	19 June	Ditto	Ditto	Ditto
Taesan Engineering						
Vacuum Technology		Puchon, Kyonggi-do	22 June	MTD	Engineer	Puchol KIM
Hanmi Metal Dies		Inchon		GoldStar Electron	Division chief	Sungyong PAK
Far East Numeric		Socho, Seoul	23 June	MTD	Engineer	Puchol KIM
New Tech Korea				Samsung Electronics	Division chief	Chinsu HAN
Hanyang Engineering		Yongin, Kyonggi-do	29 June	Ditto	Ditto	Ditto
Chaelim Engineering						
Taesok Machinery		Kumi, Kyongsang-Pukto	2 July	Ditto	Ditto	Ditto
Korea Semiconductor Equipment		Taegu	3 July	Ditto	Ditto	Ditto
Wonkiyon [expansion of "won" not given] Technology Research Inst.		Pusan	4 July	Ditto	Ditto	Ditto
Dongil Engineering		Puchon, Kyonggi-do	20 June	MTI	Section chief	Pongsik SONG
Mirae Industries				Korea Inst. for Economics & Technology	Researcher	Pyonghon SONG
Daebo Precision		Puchon, Kyonggi-do	21 June	Ditto	Ditto	Ditto
Tongyang Precision						
Daeryung Vacuum		Yongdungpo, Seoul	25 June	Ditto	Ditto	
Yuon Enterprise						
Dongil Commerce		Nonhyon, Seoul	26 June	Ditto	Ditto	Ditto

Table C. Survey Participants. [All dates are in 1990; MTI = Ministry of Trade and Industry.] (Continued)

Firm	Items surveyed	Firm location	Survey date	Surveyor		
				Affiliation	Title	Name
Aju Exim [Asia Export Import]						
Song-Won Trading		Yoksam, Seoul	27 June	MTI	Section chief	Pongsik SONG
Chein Technic		Songsu, Seoul		Hyundai Electronics	Deputy division chief	Chaewon PAENG
Fine Semiconductor Technology		Suwon, Kyonggi-do	28 June	Ditto	Ditto	Ditto